ROCKFORD INSTRUMENT LAB
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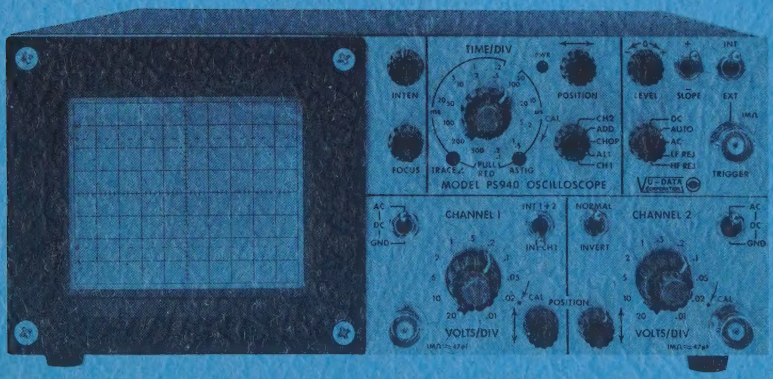
MODEL PS940A

MINI-PORTABLE OSCILLOSCOPE



U-DATA CORPORATION

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TECHNICAL MANUAL

MODEL PS940A

MINI-PORTABLE OSCILLOSCOPE

U-DATA CORPORATION

OCTOBER 30, 1974

2nd EDITION

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LIST OF EFFECTIVE PAGES

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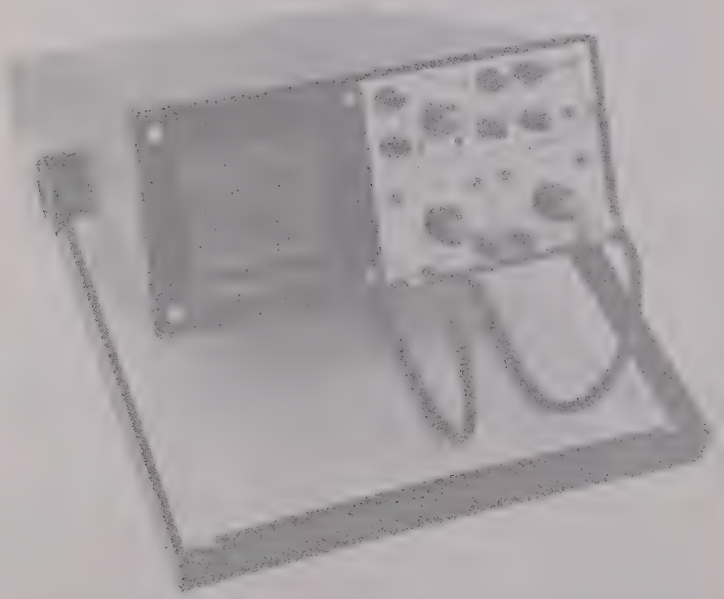
SECTION I

GENERAL DESCRIPTION



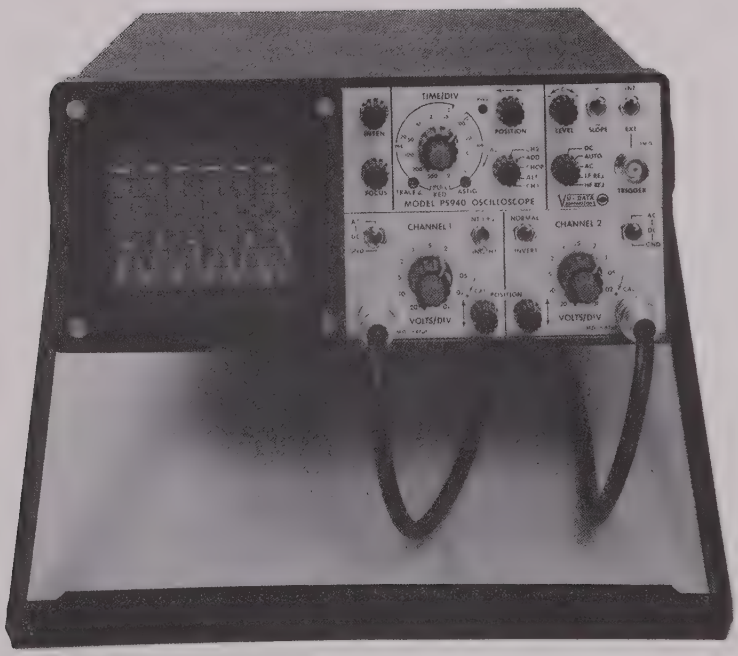


Figure 1-1. Model PS940 Mini-Portable Oscilloscope

1-1. INTRODUCTION

1-2. This manual contains complete operation, calibration and maintenance instructions for the Model PS940 Mini-Portable Oscilloscope. See Figure 1-1.

1-3. The purpose of this manual is to provide the operation, calibration and maintenance information required by the equipment operator or service technician. The manual does not include information pertaining to special equipment applications, nor does it include instructions for accomplishing repairs of the type performed at the factory.

1-4. The manual is divided into eight sections. Section I provides general information regarding the purpose of the equipment, its physical arrangement, and its pertinent specifications. Section II contains information on installation and unpacking. Section III contains instructions for operating the equipment. Section IV describes the theory of operation of the equipment, circuits and mechanisms. Section V provides test, alignment, and maintenance procedures. Section VI contains a complete parts list. Section VII contains complete circuit drawings. Section VIII provides a list of recommended spare parts.

WARNING

When performing the power supply alignment, the instrument may be operating with the covers removed. High Voltages, which could be lethal, are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The covers should be removed only for the duration of time to make the alignments. The power should be off while the covers are being removed or installed.

1-5. INSTRUMENT DEFINITION

1-6. The Model PS940 is classified as a "mini-portable" oscilloscope, and as such serves as a useful high frequency, visual trouble-shooting tool. It includes all the basic vertical, horizontal, trigger and display features of a laboratory oscilloscope, yet it is packaged in a form which makes it ideal for use in mobile and field service applications. By definition, "mini-portable" implies a size small enough to fit into a tool kit or brief case, a weight of 10 to 15 pounds or less (including batteries), and self-contained battery operation.

1-7. As the following specifications indicate, the PS940 is a DC - 20 MHz bandwidth, 10 mV/div sensitivity, dual-trace, triggered sweep oscilloscope. A delay line is included to facilitate viewing the leading edge of pulses and other fast risetime phenomena. Risetime is 18 nsec. Chopped and alternate sweep features are provided, including Channel 1 only and Channel 2 only, as well as add and invert mode functions. Twenty-one sweep ranges from 500 msec/div to 100 nsec/div are included. Internal or external triggering is provided, including automatic and manual DC or AC coupled level control; high and low frequency reject capability is also included. The unit can be triggered from Channel 1 only, or alternately from Channel 1 and Channel 2.

1-8. Aside from the above mentioned front panel controls, the rear panel includes the following features: switch for power on/off or battery charging; ground lug; square wave output for self test, calibration and 10:1 probe compensation; AC power line fuse holder; and external DC source/ battery pack operation (battery recharging circuitry is included within the basic unit). See Figure 1-2.

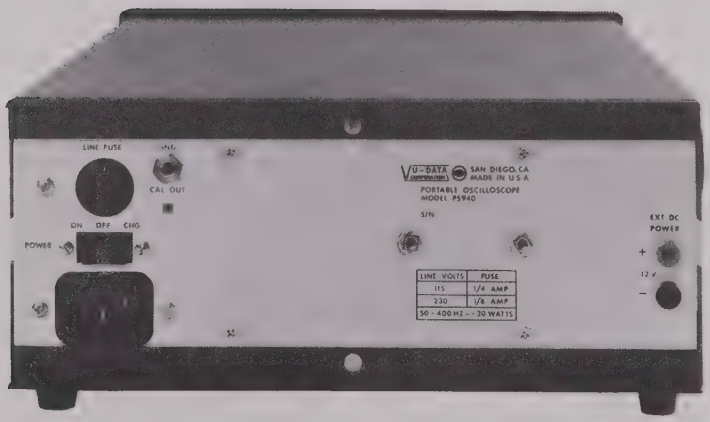


Figure 1-2. Rear Panel View of Model PS940

1-9. Standard accessories which accompany each unit at time of shipment include one each alligator clip probe (omitted if two each optional 10:1 probe kits ordered), detachable AC power line cord, one each technical manual, carrying handle/stand, front panel CRT bezel/trim strip, and front panel protective hood. Optional accessories include a battery pack, 10:1 probe kit, viewing hood for use in high ambient light conditions, rack mount kit and extender card.

1-10. APPLICATION

1-11. The PS940 brings laboratory quality to "on-site" oscilloscope test and measurement applications. It is a high performance, visual trouble-shooting tool intended for use in analog or digital circuit analysis over a DC to 20 MHz frequency range. Because of its small size, light weight and battery operation capability, it is especially convenient for in-plant mobile applications or field service work where these features are paramount to achieving the task at hand. Its vertical sensitivity, sweep rates, bandwidth and dual-trace with delay line features make it ideal for use in analog circuit applications down to the component level and digital applications down to the assembly level where a larger, heavier and more sophisticated instrument might formerly have been employed. Triggering and general performance is comparable to a laboratory oscilloscope.

1-12. PHYSICAL DESCRIPTION

1-13. The PS940 employs a plug-in assembly concept to facilitate maintenance. The entire unit is comprised of but four assemblies, each of which is self-contained. These include the vertical assembly, horizontal (sweep) assembly, power supply assembly and CRT assembly; the latter includes the master printed circuit (P/C) board and CRT driver P/C board. Each of the vertical, horizontal and power supply assemblies plugs into the master P/C board; when in place, they are held mechanically rigid by appropriately positioned machine screws. See Figure 1-3.

1-14. All major circuitry within Model PS940 consists of standard, off-the-shelf discrete components and linear integrated circuits of U.S. origin. Silicon semi-conductors and tantalum capacitors are employed to increase reliability. All principal components, voltage levels and test points are identified by reference designators and symbols; all diodes and tantalum capacitors are identified for polarity.

1-15. The front panel controls are divided into four basic groups to facilitate operation. These groups include: (1)vertical, (2)horizontal, (3)trigger and (4)trace.

1-16. A fully shielded 5 cm x 7 cm flat faced, rectangular CRT is provided and secured rigidly within the CRT assembly. The external graticule is black lined and non-illuminated. It includes 10 and 90 percent risetime reference lines within an 8 x 10 major division area. Each ¼ inch major division is divided into 5 minor divisions. Graticule area is 2.0" (vertical) x 2.5" (horizontal).

1-17. The optional battery pack is field installable, and mounts to the PS940 rear panel via two bolts which fit into heavy-duty, pre-positioned mounting inserts. Electrical interface with the unit is accomplished through the external DC source input connectors on the rear panel. The battery pack includes the battery, battery housing, and trim cover plus a battery charge meter. Necessary battery recharging circuitry is contained within the basic PS940.

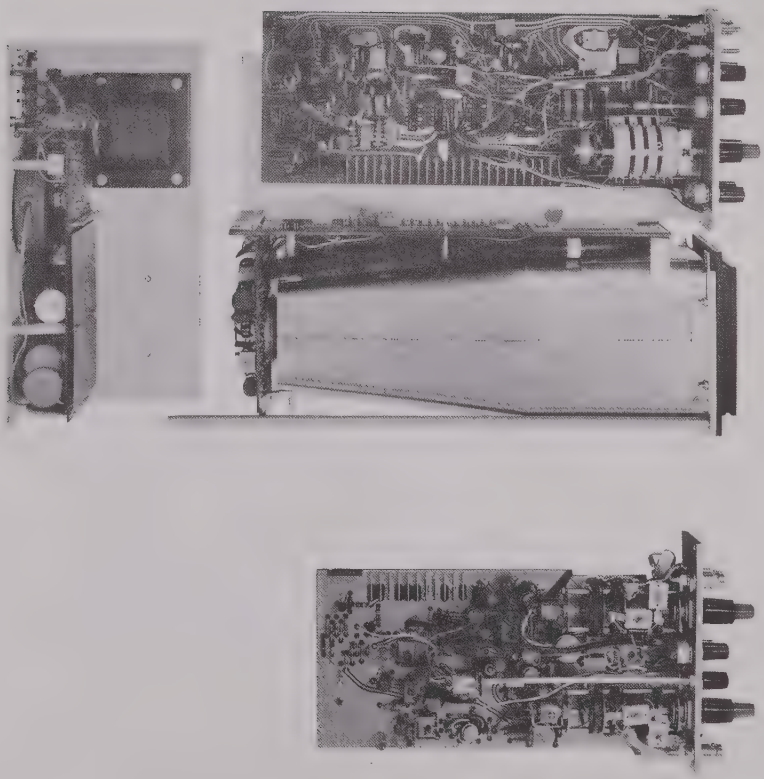
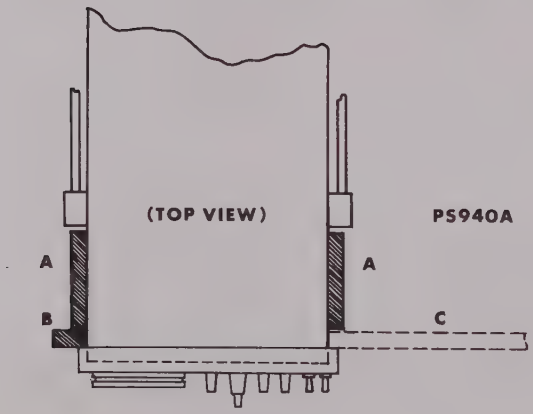


Figure 1-3. Sub-Assemblies Comprising Model PS940

1-18. Model PS940 may be rack or panel mounted by installing the optional rack mount kit. As shown in Figure 1-4, below, the unit is mounted through a 1/8" thick panel opening equal to the height and width dimensions listed in Figure 1-5 by removing the trim strip and securing the two side bars to the panel with 6-32 screws on either side; the trim strip is then re-installed. The PS940 may be mounted to a RETMA rail and/or panel by adding the 1 in. ear(s) provided with the optional rack mount kit.



The above diagram shows the rack/panel mount kit provided with the PS940A. Parts "A" (2 each) and "B" (2 each) are included. The "A" parts are used for panel mounting through a 1/8 or 3/16 inch thick panel opening equal to the height and width dimensions of 3.520 x 8.520. Two 6-32 screws are used on either side to secure the "A" parts, and PS940A to the panel. For rack mounting applications, "B" is used as a 1 inch ear for convenient mounting to the RETMA rail, while "C" is a customer supplied filler panel. The instrument should be supported at the rear when rack mounted.

Figure 1-4. Model PS940A Rack Mounting Configuration

1.10 SPECIFICATIONS

VERTICAL DEFLECTION

BANDWIDTH: DC to greater than 20 MHz within 3 dB.
COUPLING: AC, DC or Ground, selectable. Low frequency limit with AC coupling is less than 2 Hz.
RISETIME: Less than 18 nsec.
DEFLECTION FACTOR: 10 mV/div to 20 V/div in 11 calibrated ranges, 1 2 5 sequence; all ranges accurate to within 3% with vernier in Calibrate position. Vernier: Continuously variable between ranges; extends maximum deflection factor to approximately 50 V/div.
DISPLAY MODES: Channel 1 only, Channel 2 only (normal or inverted), Alternate; Chopped (approximately 100 KHz rate); Added.
DELAY LINE: Allows leading edge of signal to be displayed.
INPUT R and C: 1 megohm within 2% paralled by approximately 47 pF.
MAXIMUM INPUT VOLTAGE: 400 V (DC + peak AC).

HORIZONTAL DEFLECTION

TIME BASE: 100 nsec/div to 500 msec/div in 21 calibrated ranges, 1 2 5 sequence; all ranges accurate to within 3% F.S. over center 8 divisions and 5% F.S. over 10 divisions, with vernier in Calibrate position. Vernier: Continuously variable between ranges; extends slowest sweep rate to approximately 1.25 sec/div.

TRIGGER

MODES: Automatic or manual level, "+" or "-" slope selection; internal or external. Automatic operation eliminates trigger level adjustments and is functional above 40 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates. Internal trigger source: Internal (displayed signals) or Internal Channel 1 signal only.
COUPLING: AC, AC LF REJ & HF REJ and DC for internal and external triggering.
AMPLITUDE REQUIREMENTS: 0.4 div deflection (internal) or 150 mV external to 2 MHz, increasing to 1.3 div deflection (internal) or 300 mV external at 20 MHz. Requirements increase below 60 Hz with AC coupling, below 50 KHz with AC LF REJ coupling, and above 50 KHz with AC HF REJ coupling.
EXTERNAL INPUT R & C: 1 megohm paralleled by approximately 47 pF.
MAXIMUM INPUT VOLTAGE: 200V (DC + peak AC).

CRT

CRT: Flat faced rectangular with 8 x 10 div display area, each div is ¼ inch. CRT uses low-power filament to enhance battery operation. P31 phosphor normally supplied.
GRATICULE: Black, vertical and horizontal centerlines marked in 5 minor divisions per major ¼ inch division. 10 and 90 percent reference lines included.

ENVIRONMENTAL

AMBIENT TEMPERATURE: Operating: 0°C to +55°C. Non operating: -55°C to +75°C without batteries. -40°C to +50°C with batteries. Charging: +5°C to +40°C.
ALTITUDE: Operating: 15,000 feet maximum. Non operating: 50,000 feet.

SHOCK AND VIBRATION: Will withstand the shock and vibration conditions encountered in normal commercial shipping and handling.
HUMIDITY: Will operate up to 95% relative humidity, non-condensing.

GENERAL

PROBE COMPENSATOR/AMPLITUDE CALIBRATOR: 1V p-p, 1 KHz square wave at external jack on rear panel, accurate to within 2%. Output impedance approximately 10 Kohms.
PROBES: Standard oscilloscope probes can be employed. One 3 ft. alligator clip probe normally provided. 10:1 Probe Kit available (Option PS9008) which includes as a minimum, one compensator lead assembly, 10:1 probe lead, circuit clip-on-tip and ground lead.
POWER SOURCES:
Self-contained DC source: Chassis includes provision to accept rear panel mounted optional battery pack (Option PS9010) which provides up to 3 hours of operating time, recharging circuitry is included within chassis. Internal recharging circuit includes protection techniques so that batteries cannot be overcharged.

External DC source: Rear panel mounted jack allows unit to be operated from external DC source of 10V to 16V; approximately 12 watts.
External AC source: Operates from an external AC source of 105V to 125V, or 207V to 253V (selected by rear panel slide switch); 50 to 400 Hz; approximately 20 watts.
DIMENSIONS AND WEIGHTS (Approximate):
Height: 3½" (8.90 cm)
Width: 8½" (21.59 cm)
Depth: 12" (30.48 cm); add approximately 3" (7.62 cm) for battery pack.
Weight: 9.5 pounds (4.3 kg); add 3.5 pounds (1.6 kg) for batteries; add 5 pounds (2.3 kg) for shipping.

1-20. ORDERING INFORMATION

1-21. Additional units of the Model PS940, as well as the optional accessories listed below, may be ordered from any authorized factory field representative or directly from the factory address appearing on the front cover of this technical manual. Price and delivery information is available in current published product literature, or may be obtained by contacting the factory directly or through an authorized field representative.

1-22. Basic Model and Options Include:

MODEL PS940 Portable Oscilloscope (includes detachable AC power line cord, technical manual, carrying handle/stand, front panel CRT bezel/trim strip, front panel protective hood and alligator clip probe (omitted if two each Option PS9008 ordered))
OPTION PS9008 10:1 Probe Kit (includes as a minimum one compensator lead assembly, 10:1 probe head, circuit clip-on tip and ground lead)

OPTION PS9010 Battery Pack (includes lead-acid battery, mounting bracket and trim cover)

OPTION PS9011 Viewing Hood (snaps on to CRT bezel to shield display from high ambient light)
OPTION PS9012 Rack Mount Kit (includes mounting bars for panel mount as well as 1 in. ears for mounting to RETMA rail and/or panel)
OPTION PS9013 Extender Card (facilitates servicing of plug-in assemblies)
Technical Manual (one provided with each unit at No Charge; additional copies available for nominal cost)

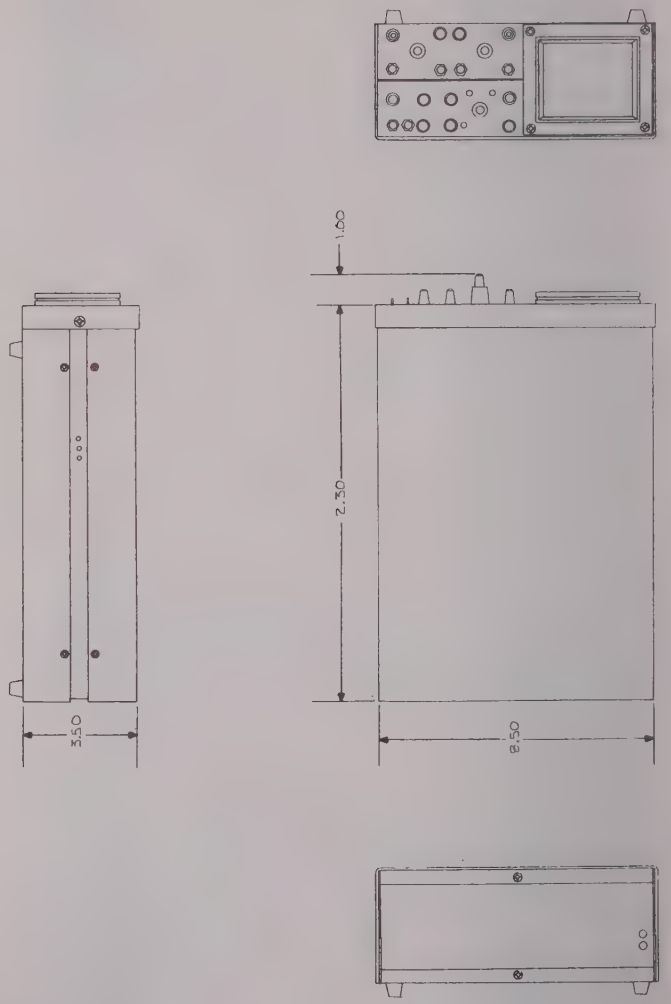


Figure 1-5. Dimensional Outline Drawing

SECTION II

INSTALLATION

2-1. INSPECTION UPON RECEIPT

The Model PS940 is aligned, calibrated, and tested under severe environmental conditions prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure that the instrument has suffered no damage in shipment.

a. A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier. If extensive damage of the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be kept for inspection.

b. A visual inspection for damage should be accomplished upon removing the instrument from the shipping container. Remove the top and bottom covers and check for loose or broken components.

2-2. BATTERY OPERATION

The battery pack is composed of six "D" size lead acid batteries connected in series to produce 12 volts DC. The individual cells are completely sealed and never need to have water added or other maintenance. Over 200 charge-discharge cycles are expected before the battery must be replaced. To operate the PS940 on batteries, unplug the AC power cord, use the power switch on the rear panel of the PS940 to turn on and off the instrument. To recharge the battery pack, plug in the AC line cord to the power line. Place the PS940 rear panel AC power switch to Charge. The battery pack should be charged for 12-14 hours to fully recharge the battery. The battery pack is trickle charged when the PS940 is operated from the AC line.

To install the battery pack to the rear panel of the PS940, perform the following steps:

1. Unplug the PS940 AC power cord and place the front panel protective hood over the front panel knobs.

2. Place the PS940 on its protective hood on a flat surface such that the rear panel is facing upwards toward you.

3. Place the battery pack spacer plate on the rear panel between the black aluminum extrusion pieces so that the two holes for the red and black external DC power jacks line up.

4. Place the white battery container on the spacer and after observing the proper polarity of the battery plug, insert the plug into the battery jacks on the rear panel. The pin connected to the red wire should be inserted into the red plus jack.

CAUTION

Do not insert the battery pack connector into the rear panel in the wrong polarity or the fuse will blow inside the PS940. Make very sure the red plus lead of the battery pack connector is inserted into the red plus jack of the rear panel. Do not short the two pins of the battery connector against any metal object since arcs and severe burns may result.

5. Place the metal plate containing the four pem nuts on top of the battery container.

6. Secure the plate and battery container to the rear panel using the two long 6-32 screws provided.

7. Secure the black plastic protective cover to the battery pack by fastening the four rubber feet with screws which pass through the feet, plastic cover and into the metal plate.

To remove the battery pack reverse the above sequence of instructions.

The battery pack may be received in a partially discharged condition due to time of shipment and handling before receipt. The battery pack should be recharged overnite before attempting to utilize its maximum operating time. The front panel power on light does not come on when the battery is being charged.

An external source of DC, other than the battery pack, may be used to operate the PS940. This external DC source should be between 10 volts and 16 volts, approximately 12 watts. Be sure to observe the proper polarity since the PS940 internal power supply is protected against the wrong external DC polarity by a clamping diode and fuse. The wrong connection will blow the fuse. The external DC input lines are insulated from the PS940 chassis ground and either the plus or minus DC lines may be connected to chassis ground without problem. The PS940 rear panel power switch will turn the instrument on and off when an external DC source is used.

SECTION III

OPERATION

3-1. OPERATING INSTRUCTIONS

3-2. FRONT PANEL CONTROL FUNCTIONS AND CONNECTIONS

The PS940 front panel controls are divided up into five sections for ease of identification and operation. These sections are as follows: Channel 1 vertical input and controls, Channel 2 vertical input and controls, trigger input and controls, sweep controls and CRT controls.

3-3. Channel 1 Vertical Section

a) BNC CONNECTOR — Signal input connector for CHANNEL 1. Impedance is 1 megohm paralleled by approximately 30 pF.

b) POSITION — Positions the CHANNEL 1 trace vertically on the CRT, also controls vertical trace position in the ADD mode.

c) AC-DC GND — 3-position switch controls the signal coupling to the vertical attenuator, either in a direct (DC), or capacitive (AC) mode. The third position (GND), grounds the vertical attenuator input without grounding the input signal.

d) VOLTS/DIV — Eleven position switch which selects calibrated vertical deflection factors from 10MV per division to 20 volts per division in a 1-2-5 sequence.

e) VERNIER GAIN — Red knob in center of VOLTS/DIV knob provides a variable deflection factor when moved out of the CAL (or detented) position. It provides for overlapping vertical deflection factors and extends the 20 volt/division range to approximately 50 volts per division.

f) INT CH 1/INT CH 1+2 — Two position switch which selects the source of internal trigger signals. INT CH 1 allows trigger signals from CH 1 only, while INT CH 1+2 selects a trigger signal which is the summation of signals in both CH 1 and CH 2 vertical amplifiers.

3-4. Channel 2 Vertical Section

a) BNC CONNECTOR — Signal input connector for CHANNEL 2. Impedance is 1 megohm paralleled by approximately 30 pF.

b) POSITION — Positions the CHANNEL 2 trace vertically on the CRT.

c) AC-DC GND — 3-position switch controls the signal coupling to the vertical attenuator, either in a direct (DC), capacitive (AC) mode. The third position (GND), grounds the vertical attenuator input without grounding the input signal.

d) VOLTS/DIV — Eleven position switch which selects calibrated vertical deflection factors from 10MV per division to 20 volts per division in a 1-2-5 sequence.

e) VERNIER GAIN — Red knob in center of VOLTS/DIV knob provides a variable deflection factor when moved out of the CAL (or detented) position. It provides for overlapping vertical deflection factors and extends the 20 volt/division range to approximately 50 volts per division.

f) NORMAL/INVERT — Two position switch which selects zero degrees (NORMAL) or 180° degrees phase shift (INVERT) of the CHANNEL 2 input signal.

3-5. Trigger Section

a) BNC CONNECTOR — External trigger signal input connector. Impedance is one megohm.

b) INT/EXT — Two position switch which selects a trigger signal from either the internal vertical signal or the signal at the External Trigger BNC connector. In the INT position, the trigger signal is dependent upon the setting of INT CH 1/INT CH 1+2 switch.

c) SLOPE + — — Two position switch allows control of the slope of the trigger signal.

d) LEVEL — Controls the point on the trigger signal wave form at which the horizontal sweep will start. This control is inoperative when in the automatic trigger mode, since in AUTO, the sweep starts at the zero axis crossing.

e) DC, AUTO, AC, LF REJ, HF REJ — Five position trigger mode and coupling switch. In DC, the trigger signal is direct coupled to the trigger generator. In the other four positions, the trigger signal is AC coupled. The AUTO mode causes the sweep to free run in the absence of a trigger signal to provide a reference baseline. In AC, the trigger amplitude requirements increase below 40 Hz. The amplitude requirements increase below 50 KHz in the LF REJ position and above 50 KHz in the HF REJ position.

3-6. Sweep Section

a) POSITION — Controls the horizontal position of the trace.

b) TIME/DIV — Twelve position, plus push-pull selector, provides 21 calibrated sweep ranges from 100 nanosec/div to .5 sec/div.

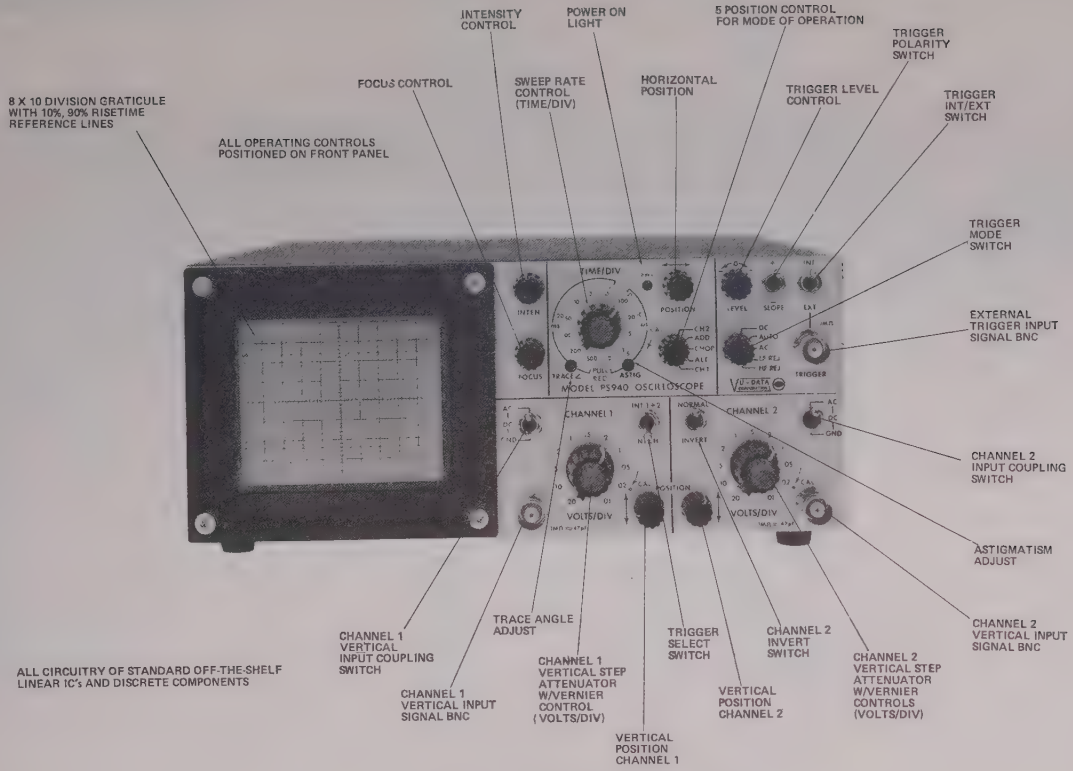

INTENSITY CONTROL
POWER ON LIGHT
5 POSITION CONTROL FOR MODE OF OPERATION
TRIGGER POLARITY SWITCH
8 X 10 DIVISION GRATICULE WITH 10%, 90% RISETIME REFERENCE LINES
FOCUS CONTROL
SWEEP RATE CONTROL (TIME/DIV)
HORIZONTAL POSITION
TRIGGER LEVEL CONTROL
TRIGGER INT/EXT SWITCH
ALL OPERATING CONTROLS POSITIONED ON FRONT PANEL
TRIGGER MODE SWITCH
EXTERNAL TRIGGER INPUT SIGNAL BNC
CHANNEL 2 INPUT COUPLING SWITCH
ASTIGMATISM ADJUST
CHANNEL 2 VERTICAL INPUT SIGNAL BNC
CHANNEL 1 VERTICAL INPUT COUPLING SWITCH
TRACE ANGLE ADJUST
TRIGGER SELECT SWITCH
CHANNEL 2 INVERT SWITCH
CHANNEL 2 VERTICAL STEP ATTENUATOR W/VERNIER CONTROLS (VOLTS/DIV)
CHANNEL 1 VERTICAL STEP ATTENUATOR W/VERNIER CONTROL (VOLTS/DIV)
CHANNEL 1 VERTICAL INPUT SIGNAL BNC
VERTICAL POSITION CHANNEL 2
VERTICAL POSITION CHANNEL 1
ALL CIRCUITRY OF STANDARD OFF-THE-SHELF LINEAR IC's AND DISCRETE COMPONENTS
MODEL PS940 OSCILLOSCOPE

Figure 3-1. Model PS940 Operating Controls

c) VERNIER — Center red knob of the TIME/DIV control slows down the sweep speed as the control is rotated counter clockwise. When the knob is clockwise in the CAL position, the sweep rate is as indicated by the TIME/DIV knob. The sweep rates indicated in red are selected by pulling out on the Vernier knob.

d) CH 1, ALT, CHOP, ADD, CH 2 — Five position switch controls the mode of operation. CH1 position selects CH 1 only. ALT provides dual trace operation with sweeps alternating between CH 1 and CH 2. In CHOP, the CH 1 and CH 2 signals are electronically switched at about a 100 KHz rate to provide dual trace. In the ADD position the CH 1 signal is added to the CH 2 signal. Vertical position for this mode is provided by the CH 1 vertical position control. The CH 2 position selects CH 2 only.

e) TRACE < — Screwdriver adjustment thru the front panel, controls the horizontal angle of the trace relative to the graticule.

f) ASTIG. — Screwdriver adjustment for control of trace astigmatism.

g) POWER INDICATOR — Red LED indicates power on.

3-7. CRT Controls

a) INTENSITY — Controls trace intensity.

b) FOCUS — Controls trace focus.

3-8. REAR PANEL CONTROL FUNCTIONS AND CONNECTIONS

a) Power ON-OFF Charge — Three position rocker power switch turns scope on for normal operation or charges the external battery pack.

b) AC Power Connector — Three terminal power cord connector.

c) 115/230V Switch — Slide switch selects the proper taps on the power transformer to match the AC line voltage.

d) Fuse — Power line fuse for instrument protection.

e) Cal — Pin jack, which provides a one volt P-P square-wave at about 1 KHz for calibrating input probes.

f) DC Power Connector — Two terminal connector for external battery power input.

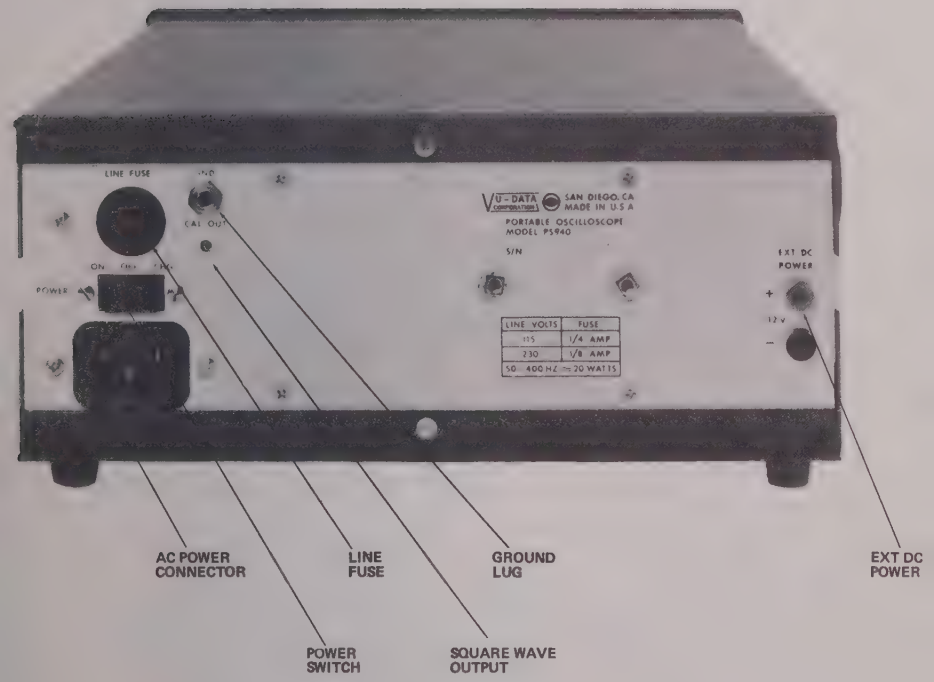


Figure 3-2. Rear Panel View of Model PS940

3-9. FIRST TIME OPERATION

When operating the PS940 for the first time, the following procedures will help you to become familiar with the operating controls and at the same time serves as a useful self test for proper operation.

a. Connect the power cord, which is supplied with the unit, to the rear panel power connector and check that the line voltage switch is set for the line voltage that you will use.

NOTE

If the line voltage switch is changed, be sure that the proper amperage line fuse is installed; ¼ amp for 115V, 1/8 amp for 230V.

b. Plug the power cord into the AC outlet and turn the power switch on the rear panel to ON. Allow one to two minutes for warm up time.

c. Set the front panel controls as follows:

AC/DC/GND Sw	CH 1 DC, CH 2 DC
Vert Atten	CH 1 .5v/div, CH 2 .5v/div
Vert Vernier	CH 1 CAL (CW), CH 2 CAL (CW)
Vert Position	CH 1 Midrange, CH 2 Midrange
INT CH 1, INT 1+2	INT 1+2
NORMAL/INVERT	NORMAL
INT/EXT	INT
SLOPE	+
LEVEL	0
TRIG Coupling	AUTO
TIME/DIV	1 ms
Sweep Vernier	CW pulled out
Horiz Position	Midrange
Mode	CH 1
INTENSITY	CW
FOCUS	Midrange

d. Connect the direct signal input cable to CH 1 vert input BNC and the high (red) clip to the CAL output jack on the rear panel. You should observe a square wave two divisions in amplitude, at a frequency of about 1 KHz. Reduce the intensity and adjust the focus for a suitable display.

e. Rotate the CH 1 vert position control so that the square wave is symmetrical about the y-axis centerline. Set the CH 1 AC/DC GND switch to AC and note the downward shift of the square wave due to the input now being AC coupled. Switch from AC to GND and note that the square wave is replaced by a line. Return the switch to DC.

f. Rotate the CH 1 vertical vernier CCW and note the square wave decreases in amplitude.

g. Switch the mode switch from CH 1 to CH 2 and connect the input cable to CH 2. You will observe the same display as previously noted. Operate the CH 2 vertical controls as just performed for CH 1.

h. Connect another signal input cable from CH 1 input BNC to the CAL output signal. Switch the mode switch to ALT and observe a dual trace display.

i. Switch to INT CH 1 and note the CH 2 trace invert as the NORMAL/INVERT switch is operated. Finding out which trace belongs to CH 2 is easily accomplished by operating the CH 2 vert position control or switching the CH 2 AC/DC/GND switch to ground.

NOTE

With the present control setup, the scope will free-run if the CH 1 AC/DC/GND switch is set to GND. This is because the trigger is being derived from CH 1 only and grounding out the CH 1 signal removes the trigger signal.

j. Switch back to INT CH 1+2 triggering and note the display as the two traces are positioned vertically apart. When the waveforms do not overlap, the normal triggering will be disturbed due to the AC coupling capacitor used in the AUTO TRIGGER mode. This is normal and may be modified by switching to DC trigger coupling or to LF REJ for high frequency signals. With the trigger selected from INT CH 1 or EXTERNAL, there is no problem in separating the traces, since there is no alternating charge disturbance of the triggering signal on the coupling capacitor.

k. Return to AUTO TRIG. Operate the slope switch from plus to minus and note the square wave polarity change at the start of the sweep.

l. Switch from AUTO to AC on the trigger coupling switch and operate the level control. The trace will disappear when the level setting is greater than the signal amplitude.

m. Operate the sweep controls changing the horizontal positioning, TIME/DIV switch and Vernier. Pull the Sweep Vernier out and note the increased sweep rate.

n. Switch to CHOP mode and note display. By switching each vertical input coupling switch to GND, TRIG mode to AUTO and adjustment of the TIME/DIV, the chopping action on the trace may be observed. Positioning the two channel vertical controls apart will display a square wave on the CRT. This shows how each input is sampled as the trace moves across the screen.

o. Switch to the ADD mode and return the vertical coupling switches to DC. Position the trace, using the CH 1 vertical position control. Operate the CH 2 NORMAL-INVERT switch and note the algebraic addition or subtraction of the signals.

p. Switch mode switch to CH 2 and note loss of CH 1 signal influence. Operate the CH 2 VOLTS/DIV switch noting the amplitude change. Switch to INT CH 1.

q. Remove the signal from CH 1 vertical input and note that the sweep freeruns. Switch from INT CH 1 to INT CH 1+2 and the display should become stable.

When a time is entered, adjust the enlargement control for the desired display.

c. Switch the CH 1 and CH 2 AC-GND Switch to ground. Adjust the trace position so that the trace is parallel with the graticule centerline.

3-10. GENERAL OPERATION

3-11. Input Signal Probes

When 10:1 probes are used with the vertical inputs, the input impedance is the time constant established with each input channel. The 0.1 μF probe may be used to preserve the full square wave signal. In using the square wave response, it is important not to exceed a frequency of about 5 kHz or the amplitude of the input will change, making proper probe compensation difficult. The proper wave-form is shown in Figure 3-2.

3-12. Channel 1 or Channel 2 Operation.

CH 1 or CH 2. The CH 1 or CH 2 is operated in two separate ways as selected by pushing the desired channel push-button switch. With the Trigger control set to INT and both CH 1 and CH 2 the Trigger Source will be internally set to the channel selected on the Mode switch. If both CH 1 is selected, the trigger signal will come from CH 1 only and may be used to synchronize the CH 2 signal frequency to that of the CH 1 signal frequency by viewing a dual trace of CH 1 & CH 2. If either CH 1 or CH 2 is selected on the CH 1 and CH 2 AC-GND switch is set to GND, there will be no trigger signal. When changing the Mode switch it is necessary to reset the setting of the trigger source polarity, coupling and level controls to make sure the display is triggered properly.

Each channel has a separate VOLTS/DIV attenuator switch with an associated vernier gain control. The switch is accurate when the vernier gain control is in the calibrated CAL position. The gain control has a minimum of 2.5 to 1 change so that VOLTS/DIV ranges of each channel can be set.

CAUTION

For accurate or precise vertical measurements, the vernier gain control must be in the CAL position (CW).

The input coupling switch for each vertical input channel is used to place DC when it is placed in the AC position. The DC response is used when it is desired to view a signal with its associated DC level, when using a 10X probe.

CAUTION

Do not exceed 400 volts DC + peak AC when the switch is in the AC position.

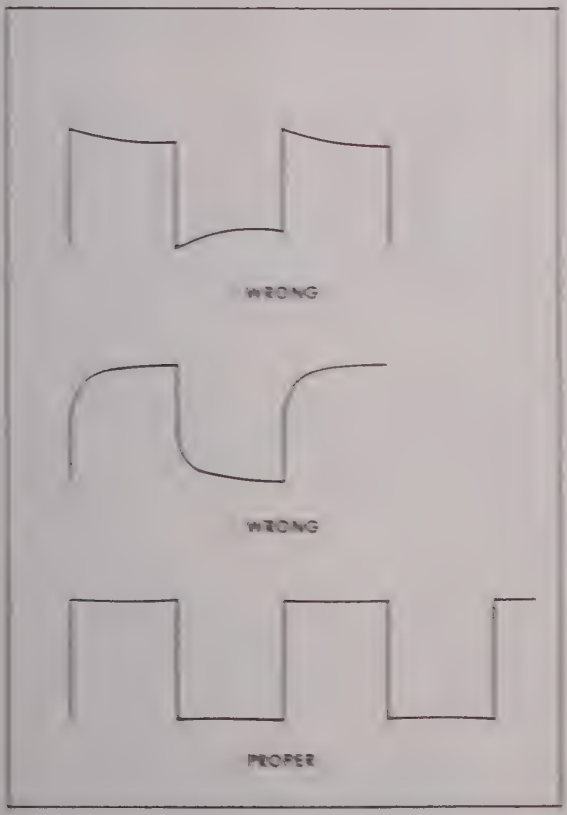


Figure 3-3. Compensated Waveforms

The GND position of the input coupling switch is useful when positioning the trace to a zero volt or other reference level for measuring DC levels.

3-13. Alternate Trace Operation

Dual trace operation is selected by placing the Mode switch to ALT. In this position, the trace alternates full sweeps between CH 1 and CH 2. Each trace may be vertically positioned by the CH 1 and CH 2 position controls, however horizontal movement of both traces is controlled together by the horizontal position control.

With the trigger controls placed in AUTO, INT and INT CH 1+2, the sweeps will be properly triggered, provided the signals overlap each other. When the waveforms do not overlap, the normal triggering will be disturbed due to the AC coupling capacitor used in the AUTO trigger mode. This is normal, and may be modified by switching to DC coupling, or to LF REJ for high frequency signals. In LF REJ, the coupling capacitor is much smaller, reducing its effect. Switching to INT CH 1 will also remove the sweep jitter, because the trigger signal is only taken from the CH 1 vertical amplifier before the electronic chopper. This trigger mode is useful for determining the phase relationship between the CH 1 and CH 2 signals. In INT CH 1+2, the phase relationship of the two traces is not determined since the trigger signal is derived alternately from each vertical channel so that the start of one sweep may not be time related to the start of the next sweep.

3-14. Chop Operation

In the CHOP Mode, an electronic chopper operating at a frequency of about 100 KHz alternately connects the CH 1 and CH 2 vertical amplifiers to the vertical output amplifier. It is useful for dual trace display of low frequency signals. Each channel is sampled for about 10 microsec intervals alternately as the trace sweeps horizontally across the CRT face. For stable triggering, INT CH 1 should be selected. INT CH 1+2 contains components of the chopped waveform and will result in trace jitter.

3-15. Add Operation

The ADD Mode algebraically adds the CH 1 waveform to the CH 2 waveform. To subtract CH 2 from CH 1, operate the CH 2 INVERT switch. Use CH 1 vertical position control to move the trace vertically, since the CH 2 vertical position control is inoperative in this mode. Triggering may use either EXT, INT CH 1 or INT CH 1+2 sources. In INT CH 1+2 the trigger signal is the algebraic sum or difference composite of the two vertical input signals and is useful in special triggering situations; for instance, where it is desired to trigger on a noise pulse which is present after addition or subtraction of the two input waveforms.

When switching to the ADD Mode, the trace at times may be driven off screen due to the addition of DC components in the waveform. If the trace is not visible, use the CH 1 vertical position control to bring the trace on screen and the vertical attenuator switches to reduce the amplitude.

3-16. Triggering

The PS940 may be triggered from an external or an internal source. The internal source has two modes e.g. (1.) INT CH 1+2 signal is the composite of the two vertical input signals taken after the electronic chopper. (2.) INT CH 1 signal is from CH 1 vertical amplifier only and removed before the electronic chopper. For CH 1 or CH 2 mode, either internal trigger source may be used. In ALT

Mode, either source may be used; however, INT CH 1 will give a valid phase relationship between the two traces. In CHOP Mode, use INT CH 1 for jitter-free triggering. Either INT CH 1+2 or INT CH 1 may be used in the ADD Mode.

The SLOPE switch selects either the plus or minus slope of the waveform at which the sweep starts, and the LEVEL control determines at what point on that slope the trigger occurs. The LEVEL control is disabled when in the AUTO or freerun trigger condition. In AUTO, a bright baseline is provided for reference when there is no input signal for triggering. AUTO is AC coupled and requires increasing trigger signal amplitude below about 40 Hz. Except for DC coupling, the trigger signal AC coupling is as follows: AC-amplitude requirements increase below 40 Hz, LF REJ-amplitude requirements increase below 50 KHz, HF REJ-amplitude requirements increase above 50 KHz.

3-17. Sweep Control

The time per division of the horizontal sweep is controlled by a 12 position rotary switch, a push pull magnifier, and a rotary vernier pot for uncalibrated sweeps. In the CAL (CW) position of the vernier, time may be read directly from the graticule by multiplying the number of horizontal divisions of interest by the selected TIME/DIV factor. For example, if one cycle of a waveform takes 10 horizontal divisions and the TIME/DIV is set to 1 usec with vernier in CAL, the time per cycle would be 10 usec and the frequency is 100 KHz. $F=\frac{1}{t}$.

3-18. CRT Control

The trace brighteness is controlled by the INTENSITY knob. At high intensities the FOCUS knob may need readjusting. The sharpest picture will be obtained using normal intensity and adjusting both the FOCUS and ASTIGMATISM controls. ASTIGMATISM is screwdriver adjustment through the front panel. Use a sine wave when setting the FOCUS and ASTIGMATISM controls. A screwdriver adjustment is provided which controls the angle that the trace makes relative to the graticule. To adjust the TRACE ANGLE, place the trigger mode in AUTO, TIME/DIV to about 1 msec and ground both vertical inputs. Adjust the TRACE ANGLE control such that the trace is parallel with the horizontal centerline in the graticule.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

The PS940 Portable Oscilloscope circuits are contained on five printed circuit boards. The vertical deflection circuits are located on the vertical input and output boards. The trigger, sweep and mode control, blanking and horizontal deflection circuits are located on the horizontal board. The power supply including a built in battery charger, is located on the power supply board. A common master board provides the signal and power interconnections for the other four boards. Refer to Figure 4-9 Block Diagram and the Schematic Diagrams 9401023, 9401024, 9401028, 9401029, 9401031 to aid in understanding the circuit theory of operation.

4-2. VERTICAL INPUT BOARD

All of the vertical deflection circuits are located on the vertical input board, except for the delay line, which is mounted between the master board and the CRT magnetic shield, and the vertical output circuit. The CH 1 vertical amplifier is almost identical to the CH 2 amplifier up to the "add" circuit where the two channel signals are summed together. The exceptions are: (a) CH 1 has no invert switch, (b) CH 2 position control affects the output of the CH 1 electronic chopper circuit, and (c) only CH 1 has an internal trigger signal takeoff before the CH 1 chopper circuit. The analog delay line provides a signal delay to the vertical output amplifier so that the leading edge of the input signal which starts the sweep may be viewed.

Signal flow through the vertical circuit is as follows:

CHANNEL 1 vertical input signal is coupled through the AC/DC/GND switch to the X1 or ÷ 100 input attenuator. The input X1 buffer amplifier U-1 has a high input impedance (so that the input attenuator will not be loaded) and has a low output impedance to drive the post attenuator. The post attenuator has the vernier control providing variable gains between fixed attenuator steps of ÷ 1 to ÷ 50. The combination of input and post attenuators normalizes the input signal to 80 millivolts full scale peak to-peak. Another X1 buffer amplifier unloads the post attenuator and drives the CH 1 chopper circuit. Selecting CH 1 turns the chopper switches on continuously. In the ALT mode the CH 1 chopper switches are on for one sweep and off the next sweep, while the CH 2 chopper is on. The CHOP mode causes the CH 1 and CH 2 chopper switches to alternate at about a 100 KHz rate between channels during the same sweep. Both CH 1 and CH 2 switches are turned on continuously for the ADD mode. For the CH 2 mode, the CH 1 chopper is off, with the CH 2 chopper on. Each channel chopper may be considered as a two pole single-throw electronic switch controlled by a transistor driver. In the CH 1 chopper, one pole (A) conducts input signals and the other pole (B) conducts CH 1 vertical position dc levels. See Figure 4-1.

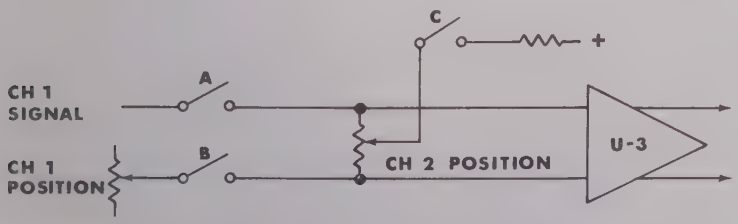


Figure 4-1. Chopper Connections

When the CH 1 chopper is off (A and B open), Switch C is turned on allowing the CH 2 position control to affect the DC output of U3. The CH 2 chopper works identically except that the position control is replaced by an internal balance adjustment.

The amplified CH 1 signal output of U3 is added to signals from CH 2 in a resistive summing network. The output of this "add" circuit is dependent upon the state of the chopper switches as controlled by the mode switch. The INT CH 1+2 trigger pickoff is taken from the addition of CH 1 and CH 2 signals at this point. (INT CH 1 trigger pickoff is taken before the CH 1 chopper.) The added signals leave the vertical board and are delayed by the delay line before driving the vertical output amplifier. This differential input and output amplifier has the required gain and dynamic range to drive the capacitive load of the CRT vertical deflection plates.

The CH 1 vertical circuits are repeated for CH 2 up to the summing network. A reversing switch changes signal and ground to the CH 2 chopper thus providing the CH 2 invert function without affecting the position of the CH 2 trace on the screen.

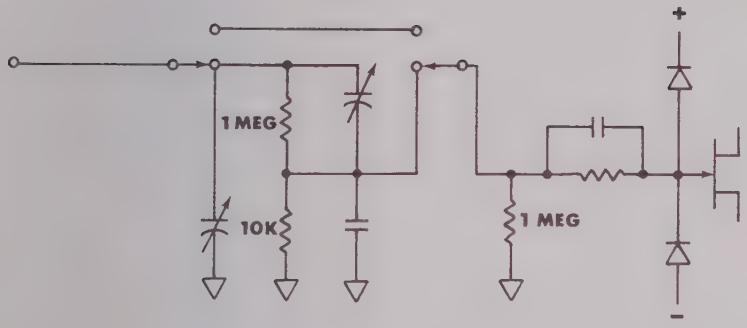
4-3. Detailed Description

Switch S305 couples the CH 1 vertical input signal from the BNC connector, J301 through C301 for AC coupling, or direct for DC, to the CH 1 input attenuator switch S101. S305 has a position to ground the input to the vertical amplifier without grounding the input signal source. This position gives a ground reference to aid in positioning the CRT trace. The signal is coupled from the input attenuator switch through overload protection elements R127, C109, CR3 and CR4 to unity gain buffer amplifier U1. R4 adjusts the DC output of U1 to zero volts. U1 drives the post attenuator and vernier gain control mounted on the rear of the attenuator switch. Refer to Table 4-1 for the vertical input and post attenuator relationship.

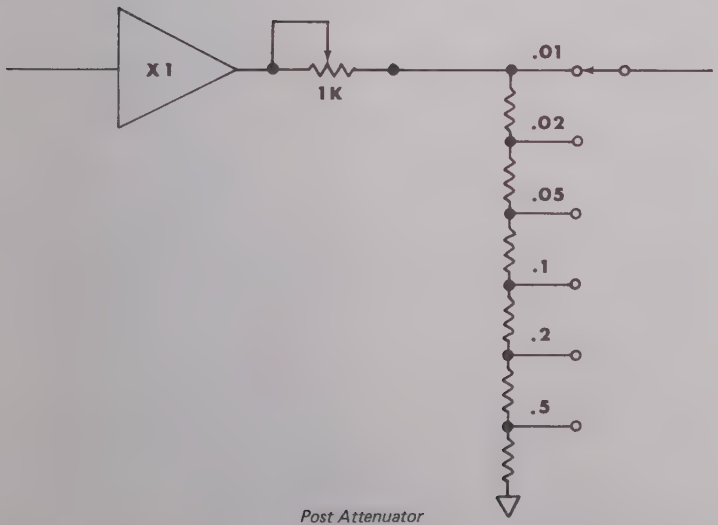
Table 4-1. Vertical Attenuation Relationships

Volts/Div	Input Atten.	Post Atten
.01	X1	X1
.02	X1	÷ 2
.05	X1	÷ 5
.1	X1	÷ 10
.2	X1	÷ 20
.5	X1	÷ 50
1	÷100	X1
2	÷100	÷ 2
5	÷100	÷ 5
10	÷100	÷ 10
20	÷100	÷ 20

At low frequencies the vertical input attenuator resistors provide the attenuation, while the shunt capacitors become dominate at high frequencies. Attenuator peaking is controlled by C102. C103 maintains a constant input capacity so that an external divide by ten probe may be used. R109 provides the one megohm input resistance. See Figure 4-2.



Input Attenuator



Post Attenuator

Figure 4-2.

The Darlington connected emitter followers of U2 have a very high input impedance to prevent loading of the post attenuator. The DC positioning voltage for CH 1 is fed to Pin 9 of U2. U2 drives the two electronic chopper diodes CR5 and CR6. Conduction of the two chopper diodes is controlled by switch Q2 coupling a DC level through diodes CR7 thru CR11. When Q2 collector is at ground, CH 1 signals will pass through the chopper diodes CR5 and CR6. When Q2 collector goes high, CR5 and CR6 will be back biased, preventing signals from reaching U3. In this state R326 effects the DC level reaching the input of U3 and controls the positioning of the CH 2 trace. R13 adjusts for any inequality in the "on" voltage of CR5 and CR6. R17 adjusts the gain of U3 and is the vertical gain calibration control for CH 1. Emitter follower Q1 picks off the CH 1 trigger signal which is added to the CH 2 trigger signal via R20 and R62. The INT CH 1 trigger signal is coupled through X1 buffer amplifier U4 to the INT CH 1, INT 1+2 trigger selector switch. R40 adjusts the level of the INT 1+2 trigger signal to match that of INT CH 1 (about – 1.2V). U5 amplifies the selected trigger signal by about 12. See Figure 4-3.

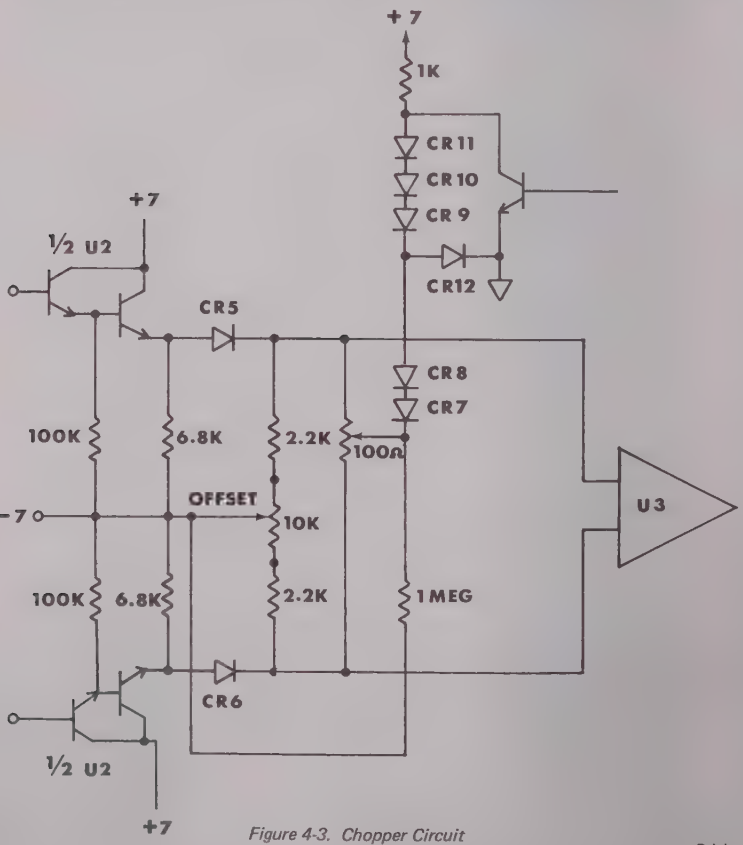


Figure 4-3. Chopper Circuit

Vertical signals for CH 2 are coupled through the attenuators and U6, U7 and U8 in the same manner as CH 1. R53 is used to balance the output of U8. When in the CHOP mode, R59 is the gain CAL control for CH 2. Q4 controls the CH 2 chopper. S307 inverts CH 2 signals.

The resistive summing network for CH 1 and CH 2 signals is composed of two 2.0K resistors located off the master board whose junction drives the delay line. The output of the delay line is terminated by a 1.0K resistor located on the vertical output board. See Figure 4-4, for how the delay line is connected in the circuit. Signal loss through the summing network and delay line is four.

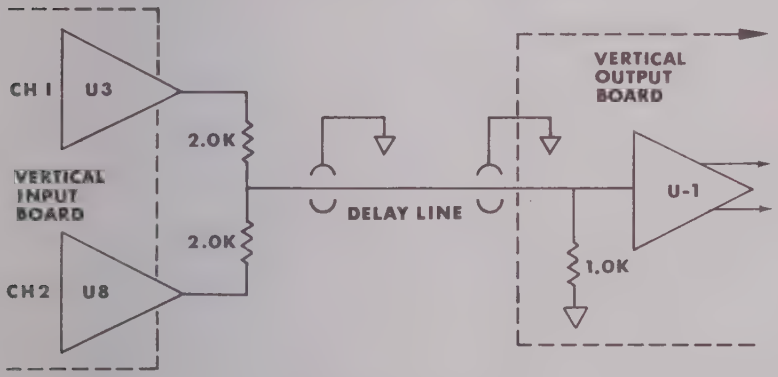


Figure 4-4. Delay Line Connections

4-4. VERTICAL OUTPUT BOARD

The vertical output board converts the single ended signal into a differential signal so that it may be amplified in the vertical output amplifier which drives the CRT vertical deflection plates, Y-1 and Y-2. The single ended to differential output conversion is performed by integrated circuit video amplifier U1. Discrete component high frequency transistors are used to drive the CRT deflection plates due to the high power and voltages required.

4-5. Detailed Description

The vertical signal from the delay line drives Pin 1 of U1; R5, a 1.0K 1% resistor terminates the delay line. R3 is a balance adjustment to compensate for any DC offset coming from the vertical input board through the delay line. U1 drives a common emitter differential amplifier composed of Q1, Q2 with active collector loads of Q3 and Q4. Schottky diodes, CR1 and CR2, prevent Q1 and Q2 from saturating when off screen signals are applied. R7, level adjustment sets the DC quiescent operating point of the collectors of Q1 and Q2 to plus 17V dc. C9 and R10 adjust the high frequency emitter peaking for the output transistors. C1 through C8, plus C10, provide power supply decoupling.

4-6. HORIZONTAL BOARD

The horizontal board contains all the circuits for generating and controlling a linear ramp which causes the CRT trace to sweep from left to right. It also contains the blanking driver which turns off the beam as retrace occurs and turns on the beam upon command of the sweep control logic. The board contains the oscillator which drives the electronic chopper circuits in the CHOP mode and a second gated oscillator which generates sweeps when the trigger switch is in AUTO.

The linear ramp is generated by an integrated circuit operational amplifier connected as a closed loop integrator. See Figure 4-5.

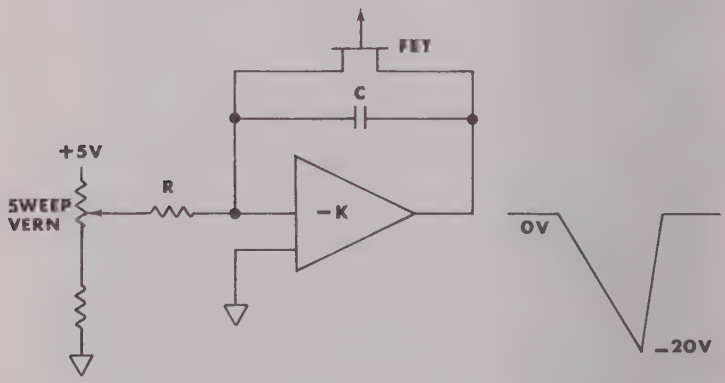


Figure 4-5. Sweep Generator

When the sweep reaches about minus 20 volts, the holdoff one shot fires, which turns on the FET switch. This shorts out the integrating capacitor in preparation for the next sweep. The rate at which the ramp is generated, dv/dt, is dependent upon the value of the integrating capacitor and the amount of integrating current flowing in R. To provide the 21 sweep ranges, four integrating capacitors are used. The other ranges are provided by switching precision resistors which change the integrating current. The time during which the integrating capacitors is being reset to zero volts changes since a larger capacitor value requires a longer time to reset. One deck of the sweep switch changes the timing of the holdoff one shot.

The horizontal output amplifier has a differential input. The linear ramp is fed to one input and the DC horizontal position control voltage is connected to the other input. The horizontal deflection plates are differentially driven by signals of about plus and minus 50 volts centered about ground. The CRT beam is turned off (blanked) while the trace is being reset to the left side of the screen. The same signal which starts the next sweep also unblanks the CRT.

The rest of the Horizontal board circuits contain the analog trigger signal conditioning, trigger comparator for analog level to digital output, and the digital mode and sweep control logic. The digital logic elements are of the TTL family.

4-7. Detailed Description

Refer to schematic Horizontal Board 9401023. Assume that the mode switch is placed in the CH 1 or CH 2 position. Trigger signals from the EXT trig BNC J201, are divided by 30 in attenuator R201 and R202 to normalize external trigger signals to the same level as internal trigger signals. INT-EXT switch S201 selects between internal or external trigger source. Trigger coupling switch S3 changes the signal coupling from DC to AC and enables the AUTO mode unijunction oscillator, Q4, in the AUTO mode. C15 and R14 change the frequency response of the trigger coupling for the LF REJ and HF REJ positions. Dual FET, U3, provides a high input impedance for the trigger coupling switch. CR7 and CR8 protect U3 from overloads. The trigger level control R203, supplies a plus and minus DC level to the gate of the second FET of U3. Q5 shorts this level to ground in the AUTO mode. Voltage differences of U3 are balanced out by offset control, R45. From the dual source follower U3, the analog trigger signal and the DC trigger level signal is fed to level comparator U4. This differential comparator converts low level analog input differences into digital logic levels at its output for driving TTL elements. Comparator hystersis is provided by R54, R44, R55 and R48. The comparator U4 drives U5, SN7451, (dual 2-wide, 2-input and/or invert gates). See Figure 4-6 for internal logic connections. The trig polarity switch S202 controls which output of the comparator is passed through the gate by grounding either pin 3 or 5 of U5. The selected output is differentiated by C34 and R38 and will set U6 flip flop $\overline{Q}2$ (pin 10) to a zero, provided that U5 gate inputs, pins 10 and 13, have been enabled by the holdoff monostable U1, 74L122. See Figure 4-7. U1 fires, when the sweep has reached about minus 20V at the output of sweep generator U2, and sets U6, $\overline{Q}2$ to a one for the duration of the holdoff time. U1 also keeps trigger pulses from reaching U6 during the hold off time, which might create false triggering. U6, Q2, pin 11, is a zero during the holdoff time. This provides zero voltage to FET switch, Q1, which shorts out the integrating capacitor of op amp integrator U2. After the hold off period, U1 resets enabling pulses from U5 to set U6, Q2 to a zero, thus starting another sweep.

In the Auto trigger mode when there are no trigger signals to fire the comparator (U4), the unijunction oscillator, Q4, starts the sweep via inverters Q2, Q3 at a rate dependent upon the selection C11, C12 or C13. When input trigger signals fire the comparator, charge is removed from the unijunction capacitor by means of CR4, and inverter Q6. This keeps Q4 from oscillating and causing out of sync trigger pulses. The auto oscillator is only enabled in the AUTO position of S3.

The slope of the sweep generator output signal is determined by which integrating capacitor is selected and the magnitude of the integrating current. Integrating capacitors, C7 and C8, form a matched set ratioed to each other to better than one percent. The parallel combination of C9 and C10 is ratioed to C7 and C8 by means of trimmer capacitor C10. The integrating capacitor, C6, for the two slowest sweep ranges is not adjusted. Rather, the integrating current is calibrated by adjusting R9 and R108. Accuracy of the integrating current on the other ranges is maintained by use of 1% metal-film resistors. Sweep vernier control, R2, slows down the sweep by lowering the voltage applied to the integrating current determining resistors. The sweep length is normally adjusted to 12 horizontal divisions by R21.

A differential amplifier composed of Q17, Q18 and Q23 has one input driven by the sweep generator and the other connected to the horizontal position control R206. The horizontal output amplifier has a differential input and differential output which drives the CRT horizontal deflection

'51 GATES . . . LOGIC & PIN ASSIGNMENTS (TOP VIEW)

7451
DUAL 2-WIDE 2-INPUT AND-OR-INVERT GATES

'51
POSITIVE LOGIC:
$Y = \overline{AB + CD}$

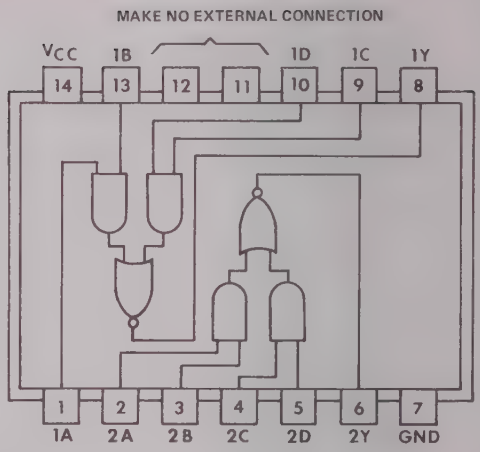


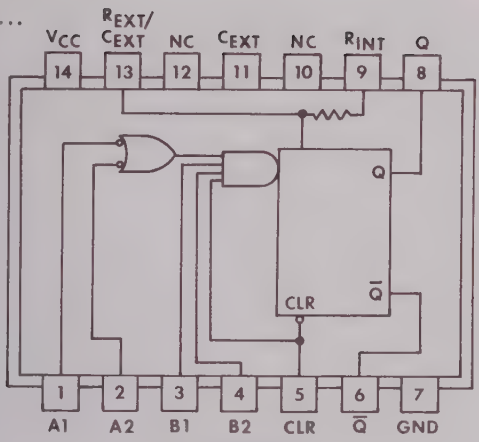
Figure 4-6. TTL Logic Elements — 7451

	INPUTS				OUTPUT
PINS	1	13	9	10	8
PINS	2	3	4	5	6
	1	1	X	X	0
	X	X	1	1	0
	0	X	0	X	1
	X	0	X	0	1
	X	0	0	X	1
	0	X	X	0	1

Table 4-2. SN7451 Truth Table

MONOSTABLE MULTIVIBRATOR ...
LOGIC & PIN ASSIGNMENTS
(TOP VIEW)

RETRIGGERABLE MONOSTABLE
MULTIVIBRATOR WITH CLEAR



SN74L122(N)
'L122..... R_{INT} = 20KΩ NOM

FUNCTION TABLE

					OUTPUTS	
CLEAR	A1	A2	B1	B2	Q	$\overline{Q}$
L	X	X	X	X	L	H
X	H	H	X	X	L	H
X	X	X	L	X	L	H
X	X	X	X	L	L	H
X	L	X	H	H	L	H
H	L	X	↑	H	⎍	⎎
H	L	X	H	↑	⎍	⎎
H	X	L	H	H	L	H
H	X	L	↑	H	⎍	⎎
H	X	L	H	↑	⎍	⎎
H	H	↓	H	H	⎍	⎎
H	↓	↓	H	H	⎍	⎎
H	↓	H	H	H	⎍	⎎
↑	L	X	H	H	⎍	⎎
↑	X	L	H	H	⎍	⎎

NOTES:

A. H = high level (steady state)
L = low level (steady state)
↑ = transition from low to high level
↓ = transition from high to low level
⎍ = one high-level pulse
⎎ = one low-level pulse
X = irrelevant (any input, including transitions)

B. To use the Internal Timing resistor of '121, 'L121, '122, or 'L122, connect R_{int} to V_{cc}

C. An external timing capacitor may be connected between C_{ext} and R_{ext}/C_{ext} (positive).

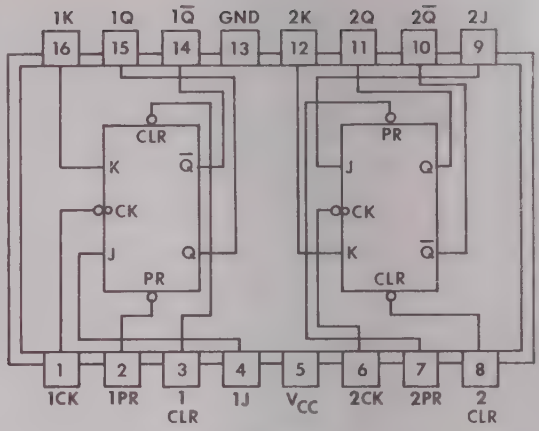
D. For accurate repeatable pulse widths, connect an external resistor between R_{ext}/C_{ext} and V_{cc} with R_{int} open-circuited.

E. To obtain variable pulse widths, connect external variable resistance between R_{int} or R_{ext}/C_{ext} and V_{cc}.

Figure 4-7. TTL Logic Elements — 74L122

FLIP-FLOP.....LOGIC & PIN ASSIGNMENTS (TOP VIEW)

DUAL J-K FLIP-FLOPS WITH PRESET & CLEAR



SN7476 (N)

'76, 'H76
FUNCTION TABLE

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	Q̄
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	⎍	L	L	Q_0	Q_0
H	H	⎍	H	L	H	L
H	H	⎍	L	H	L	H
H	H	⎍	H	H	TOGGLE	

NOTES:

A. H = high level (steady state), L = low level (steady state), X = irrelevant.

B. ⎍ = high level pulse; data inputs should be held constant while clock is high; data is tranferred to output on the falling edge of the pulse.

C. ↓ = transition from high to low level.

D. Q_0 = the level of Q before the indicated input conditions were established.

E. Toggle: each output changes to the complement of its previous level on each active transition (pulse) of the clock.

*This configuration is nonstable; that is, it will not persist when preset and clear inputs return to their inactive (high) state.

NOTE: Figure 4-6, 4-7 and 4-8 description from TTL Data Book for Design Engineers, Texas Instruments, Inc., Dallas, Texas.

Figure 4-8. TTL Logic Elements — 7476

plates push-pull fashion. It is comprised of Q19, Q20, Q21, Q22 and Q24. Peaking inductors, L1 and L2 maintain sweep linearity at the highest sweep speed. R100 calibrates the horizontal amplifier for differences in CRT deflection sensitivity.

The blanking driver amplifier is driven by complementary emitter followers Q11 and Q12. The amplifier has a gain of about 30 to convert TTL logic levels to zero to minus 60 volt signals, to blank the tube. The CRT is unblanked when CRT pin 5 is at zero volts. Q13 and Q14 are the amplifier transistors and Q15 and Q16 are complementary emitter followers to drive the blanking plate.

The previous circuit description is for the mode switch in either the CH 1 or CH 2 position. To select CH 1, pin 8 of U7 is high and pin 6 low. For CH 2 select, pin 8 of U7 is low and pin 6 high. U7 is controlled by static DC levels from mode select switch S2 a, b and dynamic square waves from U6 flip-flop. To aid in understanding the operation of U7, refer to Table 4-2. In the "ADD Mode," S2 a,b, puts zeros on U7 pins 3, 13, 10 and 4, which causes outputs 6 and 8 to be "ones" turning on CH 1 and CH 2 at the same time. In the alternate mode, Q8 emitter is grounded through switch S2a, causing blanking signals to clock flip-flop No. 1 of U6 through clock input pin 1 of U6. The flip-flop changes state for every sweep, causing U7 pins 6 and 8 to alternate ones and zeros, turning on the vertical amplifiers sequentially. The flip-flop changes state during the holdoff part of the sweep cycle so that the selected channel trigger signal is present at the comparator U4 when the holdoff mono U1 resets. In the CHOP mode, the emitters of Q7, Q9 and Q10 are grounded through switch S2. Q9 and Q10 form a 200 KHz multivibrator. Its output drives inverter Q7, which clocks U6 flip-flop No. 1. The flip-flop outputs through U7 turn on and off the vertical input amplifiers at about a 100 KHz rate.

Four additional controls are located on the horizontal assembly. The trace angle control, R104, controls the magnitude and direction of current through the trace angle coil which is wrapped around the forward part of the CRT. This control tilts the trace so that the horizontal sweep may be lined up with the graticule. A second screwdriver adjust control, R103, adjusts the trace astigmatism by controlling the voltage at the A3 electrode of the CRT (Pin 6). The intensity control adjusts the voltage at the CRT grid (Pin 1) while the focus control adjusts the voltage of the focus element A2, (Pin 4).

CAUTION

The leads from the focus and intensity pots are at a high negative voltage and constitute a dangerous shock hazard. When troubleshooting, avoid these leads except when measuring their DC voltages with a very high impedance voltmeter capable of measuring over one thousand volts negative.

4-8. POWER SUPPLY ASSEMBLY

The power supply assembly consists of a printed circuit board mounted on the back panel metalwork along with various connectors and power transformers, etc. The power supply assembly may be operated and aligned without the rest of the oscilloscope by plugging a dummy load jig into

the Elco pins where the master board normally would connect. The external battery pack plugs into a rear panel connector and is not connected to chassis or signal ground. This allows either floating, plus, or minus grounded batteries to operate the PS940 in such applications as operation from a cigarette lighter jack of a vehicle.

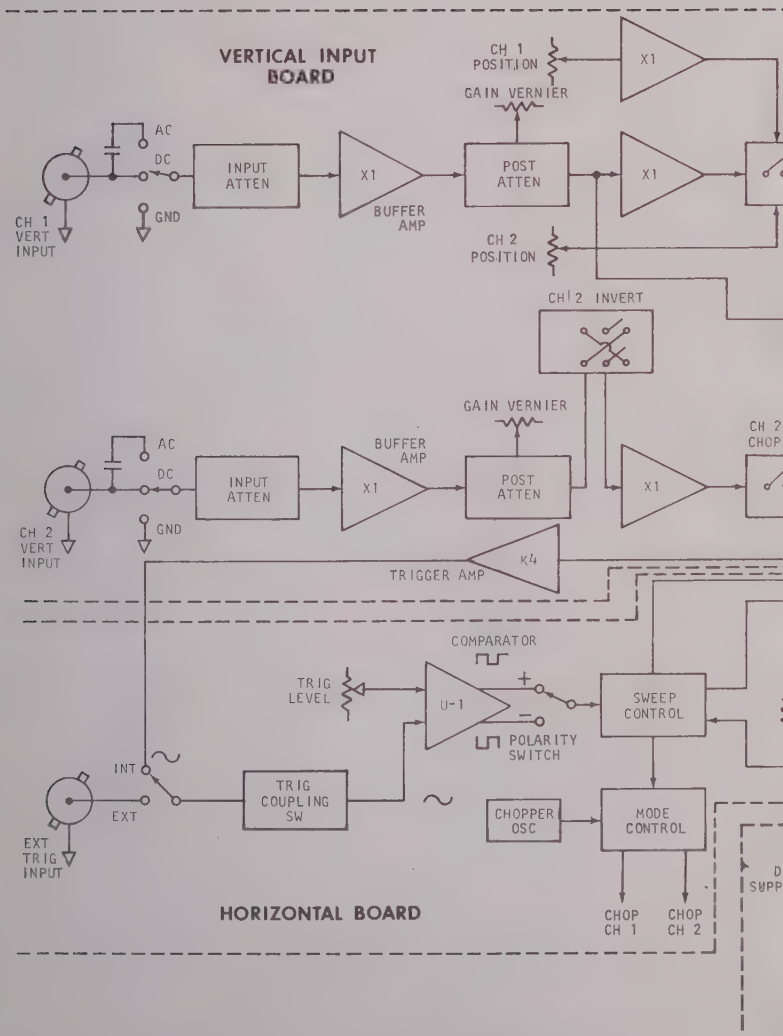
4-9. Detailed Operation

The three prong power cord is connected to J201 which grounds the chassis of the PS940 to earth when using a three prong AC outlet. For floating operation, a ground cheater plug must be connected to the power cord. The AC power is connected thru fuse F201, power switch S201 and 115-230 volt switch S202 to the power transformer T201. The line fuse is 3AG, 1/4 amp, slo blo, for 115 volt operation. Use 1/8 amp slo blo for 230 volt operation. The electrostatic shield around the primary of the power transformer is connected to chassis ground. The centertapped secondary voltage is full wave rectified by CR2 and CR3, filtered by C2, to power the constant current, voltage cutoff, battery charger Q1. CR6, CR7, CR8, in combination with R2 and R3, limit the amount of current which may be drawn from Q1. R4 drops that current when charging the battery. CR5 limits the voltage out of the charger. Fuse F1 protects the external battery in case of an internal short on the battery line.

The minus 10 volt regulator is composed of U1, Q2 and Q3. CR9 is the regulator voltage reference and R10 sets the output voltage. The DC to DC converter, composed of Q4, Q5 and T1, switches the regulated 10 volt line and dependent upon the turns ratio of the secondaries, provides ±5 volts, ±7 volts, +37 volts −27 volts, ±65 volts, ±1000 volts and the 6 volt filament square wave. The plus and minus 1000 volts are obtained by doubling the five hundred volt zero to peak square wave of T2 secondary 19-20. U2 and Q6 form a regulator circuit for the minus 1000 volt line to compensate for high voltage changes as the intensity of the trace is changed. R24 is the hi-voltage adjustment. It controls the regulator feedback voltage to U2 pin 3. Inductors L1-L3 isolate the −5 volt and ±7 volt lines from the high frequency noise generated by the converter. Bias for the CRT cathode is provided by CR36.

4-10. MASTER BOARD

The master board distributes power from the power supply board to the horizontal and vertical board assemblies and the required signal interconnections between these later three boards. One control is located on the master board. It is the geometry adjustment which removes pin cushion effect from the CRT display.


VERTICAL INPUT BOARD
CH 1 POSITION
X1
GAIN VERNIER
AC
DC
GND
INPUT ATTEN
X1
BUFFER AMP
POST ATTEN
X1
CH 1 VERT INPUT
CH 2 POSITION
CH 2 INVERT
GAIN VERNIER
AC
DC
GND
BUFFER AMP
INPUT ATTEN
X1
POST ATTEN
X1
CH 2 VERT INPUT
TRIGGER AMP
K4
COMPARATOR
TRIG LEVEL
U-1
SWEEP CONTROL
POLARITY SWITCH
INT
EXT
TRIG COUPLING SW
CHOPPER OSC
MODE CONTROL
EXT TRIG INPUT
HORIZONTAL BOARD
CHOP CH 1
CHOP CH 2

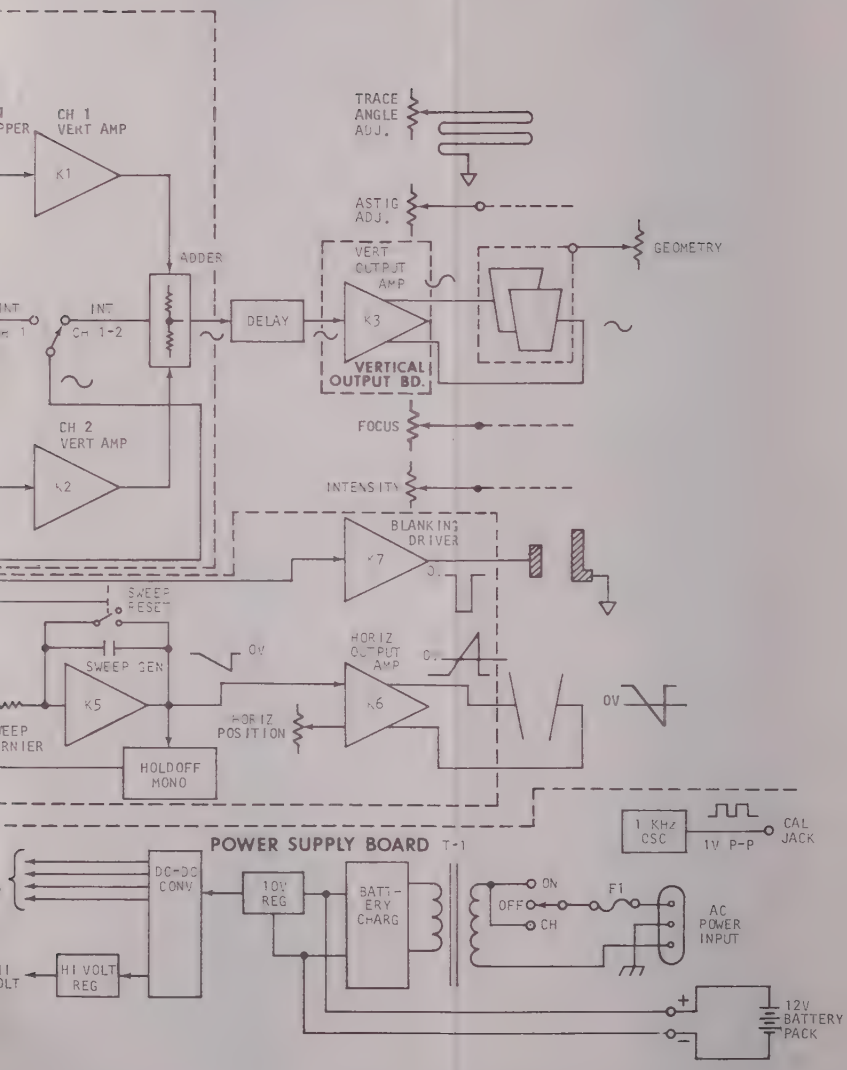


Figure 4-9. Block Diagram PS940

SECTION V

MAINTENANCE

5-1. GENERAL

This section contains information for preventive maintenance, troubleshooting, corrective maintenance and calibration.

5-2. PREVENTIVE MAINTENANCE

Preventive maintenance consists of periodic cleaning, inspection, tightening and recalibration of the oscilloscope. It should be performed on a regular basis to keep the instrument in its best operational and appearance condition.

5-3. Cleaning

Accumulations of dirt, dust and grime should be removed whenever they become noticeable. The frequency of cleaning is largely dependent upon the environment in which the instrument is used. Dirt on the outside covers may be removed with a soft cloth moistened with a diluted household cleaning solution.

CAUTION

Do not use solvents which may attack the paint or plastic parts of the instrument. Chemicals such as MEK, lacquer thinner, or strong acids and alkali may cause paint removal, shorted switches, circuits, etc. and melting of the plastic parts.

Fingerprints on the CRT faceplate should be removed with lens cleaning tissue. Dust accumulated inside the instrument may be blown out with low pressure air.

CAUTION

Whenever the covers are removed from the instrument, make sure that the instrument is unplugged from the AC power line and the battery pack is removed. The interior of the instrument contains high voltage circuits which could be hazardous to your health if the instrument power switch was accidentally turned on during maintenance, with a power source left connected.

5-4. Inspection

After cleaning the instrument, visually inspect the components on the printed circuit boards. Look for components such as resistors which may have become discolored from overheating and for wires having frayed insulation from vibration. A close visual inspection can many times uncover the source of future problems. Removal of the printed circuit boards is not recommended unless a part replacement is indicated

5-5. Tightening

Front panel knobs and any screws which might have worked loose should be tightened. The black vertical attenuator knobs and the black time per division knob may be tightened by first removing the red vernier knob and using a one quarter inch deep socket to tighten the black knobs. The other knobs are tightened with a small screwdriver. A drop of rubber cement is helpful in retaining the plastic knob end caps.

After many insertions and removals, the printed circuit board Elco pins have a tendency to spread. These may be tightened by removing the board and squeezing the pins with needlenose pliers. Care in board removal will prevent pin spreading.

5-6. Recalibration

Recalibration of the instrument atregularly scheduled intervals will assure that measurements made will be within the accuracy specifications. It is recommended that the instrument be recalibrated after 1000 hours of operation, or twice a year if the instrument is used infrequently. The calibration procedures are provided in the latter part of this section of the manual. If electronic parts, such as resistors and integrated circuits have been replaced during the preventive maintenance procedures, recalibration should be performed to return the instrument to specifications.

5-7. TROUBLESHOOTING

The troubleshooting section contains the following: precautions to be used when troubleshooting, parts identification, soldering precautions and PC board handling, troubleshooting techniques and individual board troubleshooting. The modular, plug in, printed circuit board construction of the instrument makes it simple to isolate the problem and replace the defective part. Standard off the shelf components are used throughout the instrument and replacements parts may be obtained through your local supplier instead of waiting for a part from Vu data Corp. However, care should be taken that the replacement part is an exact substitute, so that performance and calibration difficulties may be avoided.

5-8. Troubleshooting Precautions

WARNING

Before removing the covers for troubleshooting, read and observe the precautions given below. The instrument contains a hard vacuum cathode ray tube and potentially lethal high voltages, which may become hazardous if not handled properly.

1. Always remove the line cord and battery pack from the instrument before removing the covers.

2. Wear "safety" goggles with side shields when handling the CRT to prevent possible injury from flying glass in case of tube breakage. When removing the CRT from the tube shield,

be very careful of the tube tip located in the center of the tube socket. Do not strike or scratch the CRT and never subject it to more than moderate pressure when installing in, or removing from the instrument.

3. When operating the instrument with power on, and covers off, avoid contact with any of the high voltage pins on the power supply board and horizontal board. Especially avoid contact with the intensity pot when handling the instrument. Avoid touching any leads from the AC line connector through the fuse and power switch.

4. Avoid shorting power supplies.

5. Do not unplug any board with power on.

6. Avoid shorting transistor leads to ground or power supplies. It may destroy the transistors.

7. Avoid shorting integrated circuit leads, since it may damage them.

8. When operating the power supply without a load, filter capacitors will charge up, causing voltages to remain after power has been turned off.

9. Operating the power supply removed from the rest of the instrument, by using the extender cable, the shock hazard is greater due to more exposed Elco pins. USE DUE CAUTION!

10. When using the extender cable, make sure the interconnection is made on a 'pin-A to pin A' etc. basis. Otherwise, the wrong voltages may occur at improper places causing damage.

11. With a battery pack attached to the instrument, do not consider the instrument to be "dead" when the line cord is pulled.

5-9. Parts Identification

In the Parts List, each part is identified by a drawing reference designator, manufacturer part number, description of part, manufacturer and Vu-data part number. When ordering replacement parts from Vu-data, be sure to include the Vu-data part number for ease of identification.

5-10. Resistor Identification

a) Composition Resistors

Standard EIA resistor color code applies, with bands 1 and 2 being the first two significant figures, band 3 is the multiplier and band 4 is the tolerance.

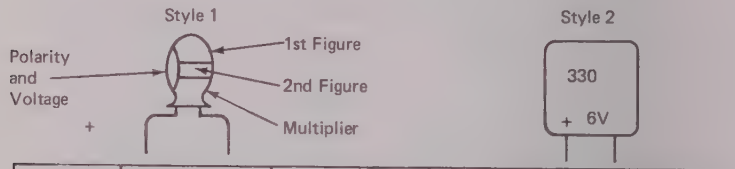
Black	0	Blue	6
Brown	1	Violet	7
Red	2	Gray	8
Orange	3	White	9
Yellow	4	Silver	10%
Green	5	Gold	5%

b) Precision Metal Film Resistors

Bands 1, 2 and 3 are the first three significant figures, and band 4 is the multiplier. Band 5 is the tolerance, and is usually brown, indicating 1%. Some mil spec resistors do not use a color code, but write the value on the body of the resistor.

5-11. Capacitor Identification

Film, electrolytic and ceramic capacitors have their capacity and voltage rating written on them. Dipped silver mica capacitors are identified by writing either in a mil spec callout (such as CM05FD270J03, a 27 pf 5% capacitor) or a commercial callout (such as 27 5%). Dipped tantalum capacitors are identified in two ways, depending on manufacturer and case size.



COLOR	1st FIGURE	2nd FIGURE	MULTIPLIER	VOLTAGE
		In PicoFarads		
Black	0	0	None	3-4
Brown	1	1	X10	3-6
Red	2	2	$X10^2$	3-10
Orange	3	3	$X10^3$	3-15
Yellow	4	4	$X10^4$	3-20
Green	5	5	$X10^5$	3-25
Blue	6	6	$X10^6$	3-35
Violet	7	7	$X10^7$	3-50
Gray	8	8	None	---
White	9	9	None	---

Table 5-1. Dipped Tantalum Capacitor Marking

5-12. Diode Marking

Diodes are marked in three different ways. The cathode end is generally indicated by a band closest to the cathode lead. Some diodes have their identification number written on the side, others use colored bands like carbon resistors, while others only identify the cathode. The latter type of diodes will require reference to the schematic or Parts List for positive identification.

5-13. Transistor Identification

The transistor lead configurations are varied as to type. When in doubt, refer to Table 5-2.

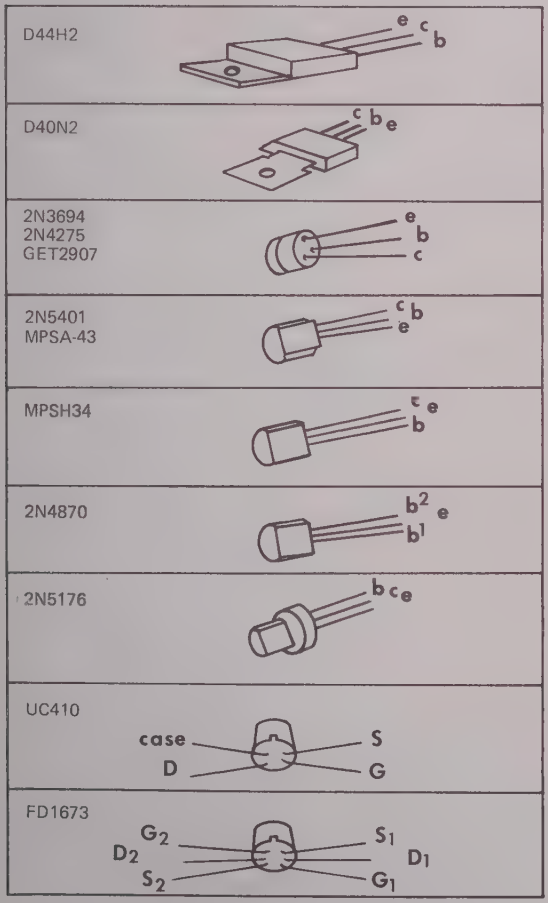


Table 5-2. Transistor Lead Identification

5-14. Integrated Circuit Identification

Six different integrated circuit packages are used in the instrument. Their pin configurations are shown below in bottom view.

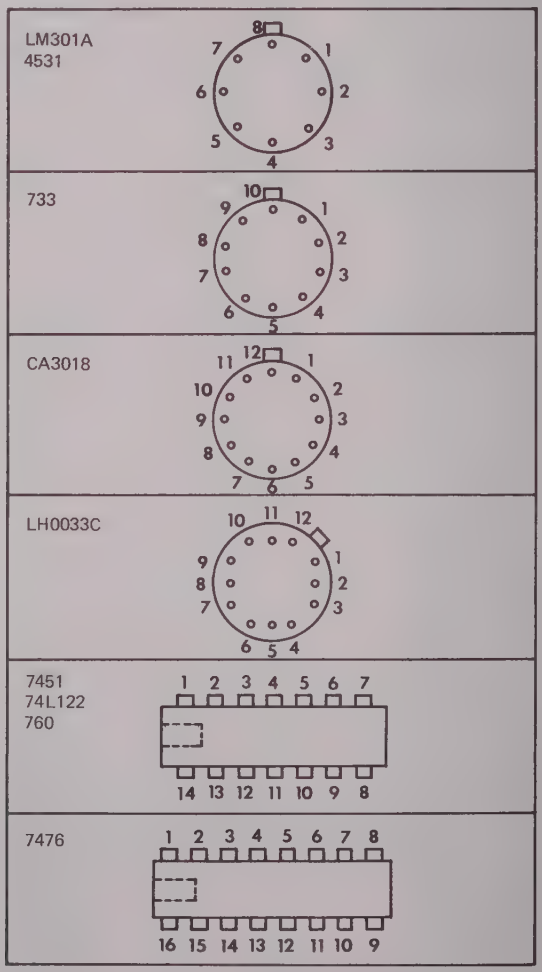


Table 5-3. IC Lead Identification

5-15. Soldering Precautions

Since the solid state components may be damaged by excessive heat, do not use a soldering iron of greater than 50 to 75 watts. Do not keep the iron tip to the solid state lead for greater than five seconds. If greater time is required, let the lead cool off before reapplying the iron. Use only resin core 60/40 solder. Never use an acid core solder. When removing components from a printed circuit board, use a solder sucking device to remove the solder from the pad. On double sided boards, remove the solder from both sides and make sure the hole is free from solder. Excessive force will sometimes remove the plating from plated through holes. Be sure to solder top and bottom of the board to assure a through connection. Clean the resin from the board with alcohol or a flux remover. Cleaned, repaired boards should be sprayed with a clear acrylic finish to moisture proof the board. When spraying, do not allow the spray to hit the wafer switches or Elco pins, as an open circuit may result. Parts replacement in many cases will require recalibration. If a pad or strap becomes lifted when removing a part, use the component lead to cinch the pad to the board before resoldering. Badly lifted straps should be replaced with wires.

CAUTION

Use a low wattage iron and speedy soldering techniques to avoid lifting pads and straps. A good solder removal tool is essential for parts replacement. Use enough heat to avoid "cold" solder joints.

5-16. Troubleshooting Techniques

WARNING

Whenever the instrument covers are removed, high voltages with exposed pins are present. A possible lethal shock could result from touching high voltage connections.

If the instrument is not operating, start with line cord and make sure it is fully plugged into the instrument and to an active AC power plug. Next, check the AC line fuse and replace, if open. Make sure that the power switch is in the ON position and not in CHG. Improper setting of the front panel controls can give the appearance of faulty operation. Check each control setting and make sure that the sweep and vertical attenuator controls are set for an on screen display.

If the preceding checks do not correct the problem, unplug the instrument and remove the battery pack. Then remove the top and bottom covers. Connect the power cord and turn the power switch to ON. Be careful of exposed high voltage points. Note the front panel power on light. If it is not on, the DC to DC converter is not running. A faint 10KHz audible sound should be heard with the covers off, provided the converter is operating properly. The power supply voltages may be checked with a DC voltmeter at the printed circuit board pins.

Most troubles with the instrument may be traced to mechanical problems, (such as open connector pins, or broken wires), or defective semiconductors. Isolation of the defective part should be done in a systematic manner, starting with the power supply and proceeding to the CRT.

5-17. Circuit Board Troubleshooting

The CRT display can be used to pinpoint the source of many troubles. A sweep with no vertical deflection indicates a trouble on either the vertical input or output boards. Conversely, no sweep with vertical deflection indicates a problem with the horizontal board. Visible retrace indicates a blanking circuit problem. If working spare boards are available, substituting boards will quickly isolate the problem to a board. Signal tracing is then used to locate the defective part.

An extender board may be used to aid in signal tracing the back side of the horizontal board and vertical input board. The extender board may also be connected between the power supply assembly and the rest of the instrument to aid in troubleshooting the vertical output board and power supply board.

5-18. CORRECTIVE MAINTENANCE

The modular, plug in printed circuit board assembly configuration of the instrument allows first level corrective maintenance to be made by replacing defective assemblies. These assemblies are as follows:

(a)	Power Supply Assembly	9405027
(b)	Horizontal Assembly	9405026
(c)	Vertical Input Assembly	9405020
(d)	Display Assembly	9405029
(e)	External Battery Assembly	9405034

Together they form a complete instrument. If a complete power supply with its switches and metalwork etc. is not required, the power supply sub-assembly, 9405028, is available. This consists of the printed circuit board, complete with active components and DC to DC converter. It does require soldering of leads to install it in a power supply assembly. A vertical output sub-assembly, 9405031, is available which contains the vertical output board and parts. It also requires soldering for installation.

Individual components are generally "off the shelf" and available at local suppliers or may be ordered from Vu-data Corp. When ordering from Vu-data, be sure to include the six digit Vu-data part number. If other parts are substituted, make sure that the part is a direct replacement, or performance and calibration difficulties may result.

Refer to Figures 5-2 thru 5-7 for the location of test points, calibration controls and pin identification. A thorough understanding of the theory of operation section is a valuable aid in tracing signals through the various circuits.

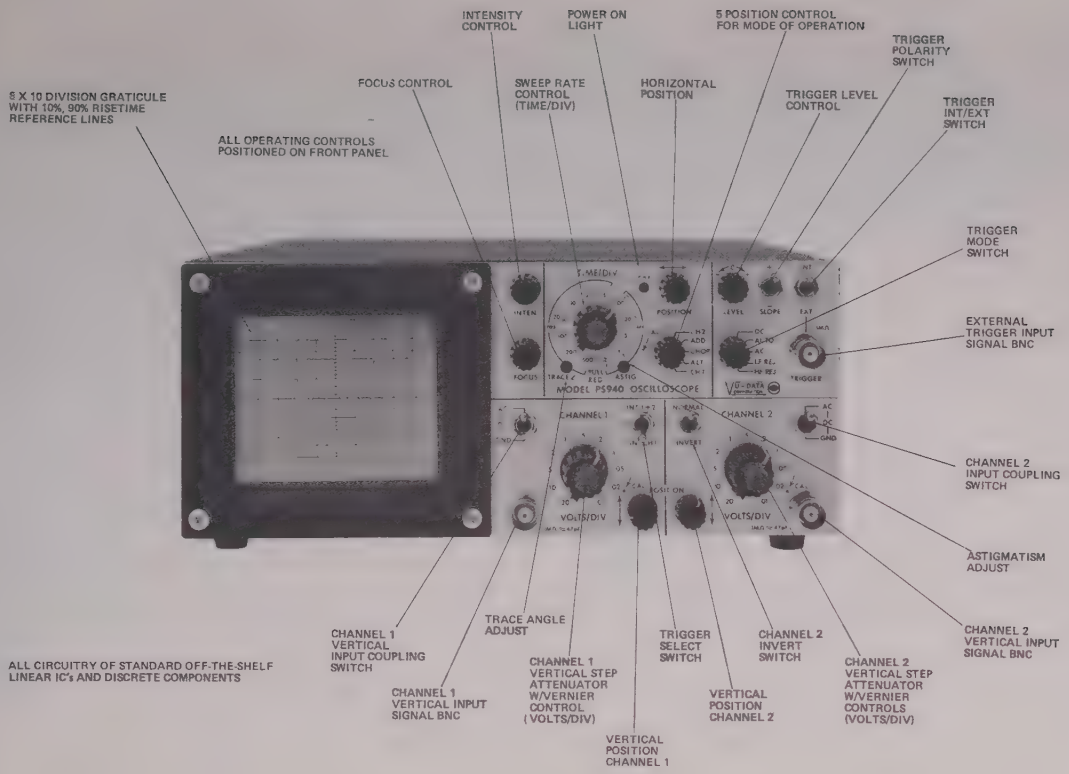

INTENSITY CONTROL
POWER ON LIGHT
5 POSITION CONTROL FOR MODE OF OPERATION
TRIGGER POLARITY SWITCH
TRIGGER LEVEL CONTROL
TRIGGER INT/EXT SWITCH
FOCUS CONTROL
SWEEP RATE CONTROL (TIME/DIV)
HORIZONTAL POSITION
8 X 10 DIVISION GRATICULE WITH 10%, 90% RISETIME REFERENCE LINES
ALL OPERATING CONTROLS POSITIONED ON FRONT PANEL
TRIGGER MODE SWITCH
EXTERNAL TRIGGER INPUT SIGNAL BNC
CHANNEL 2 INPUT COUPLING SWITCH
ASTIGMATISM ADJUST
CHANNEL 2 VERTICAL INPUT SIGNAL BNC
CHANNEL 1 VERTICAL INPUT COUPLING SWITCH
TRACE ANGLE ADJUST
TRIGGER SELECT SWITCH
CHANNEL 2 INVERT SWITCH
CHANNEL 2 VERTICAL STEP ATTENUATOR W/VERNIER CONTROLS (VOLTS/DIV)
CHANNEL 1 VERTICAL INPUT SIGNAL BNC
CHANNEL 1 VERTICAL STEP ATTENUATOR W/VERNIER CONTROL (VOLTS/DIV)
VERTICAL POSITION CHANNEL 2
VERTICAL POSITION CHANNEL 1
ALL CIRCUITRY OF STANDARD OFF-THE-SHELF LINEAR IC's AND DISCRETE COMPONENTS
MODEL PS940 OSCILLOSCOPE
CHANNEL 1
CHANNEL 2
VOLTS/DIV

Figure 5-1. Model PS940 Location of Front Panel Controls

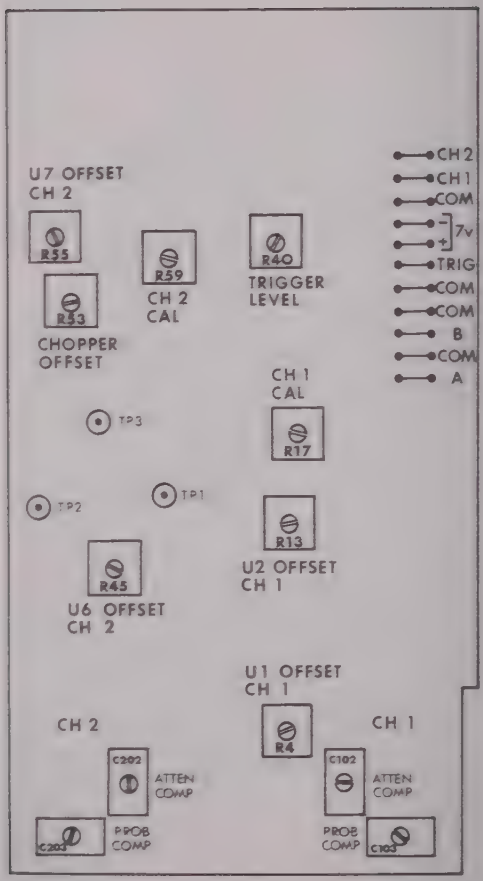


Figure 5-2. Control Location on Vertical Input Board Sub-Assembly

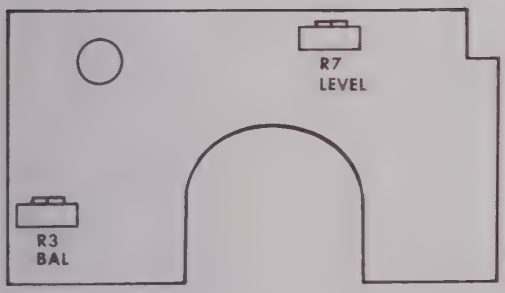


Figure 5-3. Control Location on Vertical Output Board Sub-Assembly

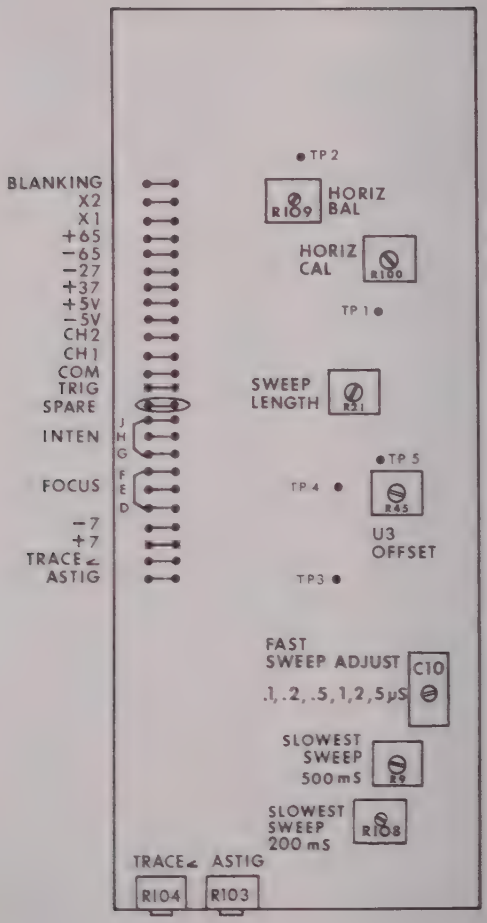


Figure 5-4 Control Location on Horizontal Board Sub-Assembly

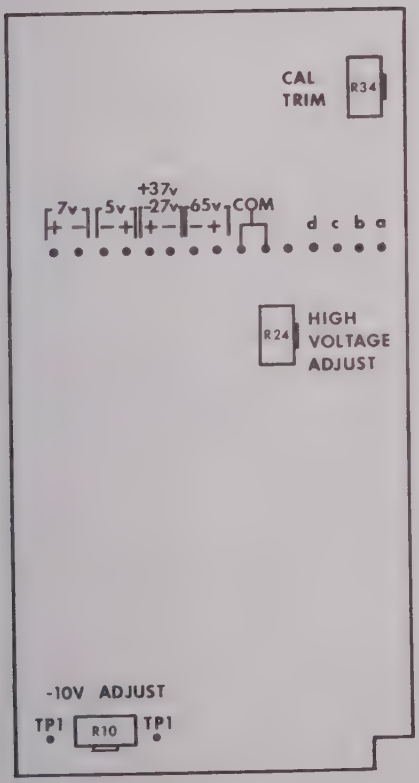


Figure 5-5. Control Location on Power Supply Board Sub-Assembly

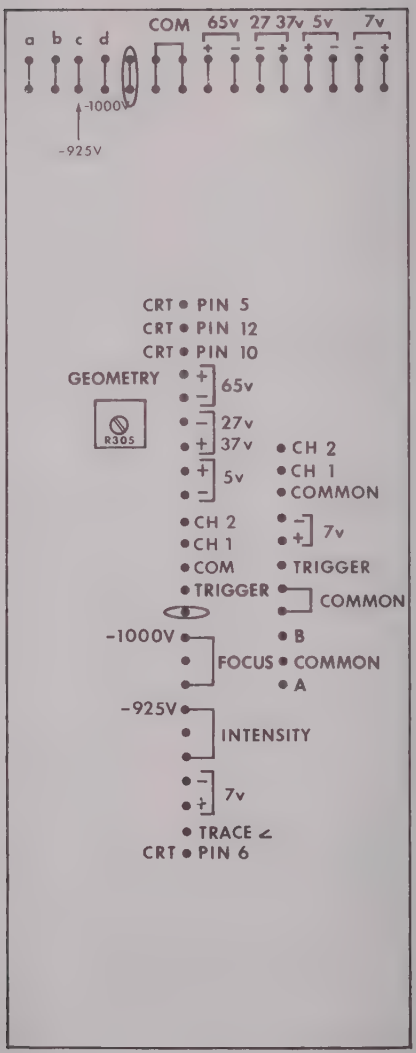


Figure 5-6. Control Location on Master Board Sub-Assembly

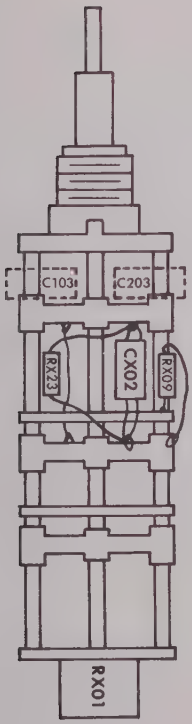


Figure 5-7. Location of Controls, Vertical Switch Assembly

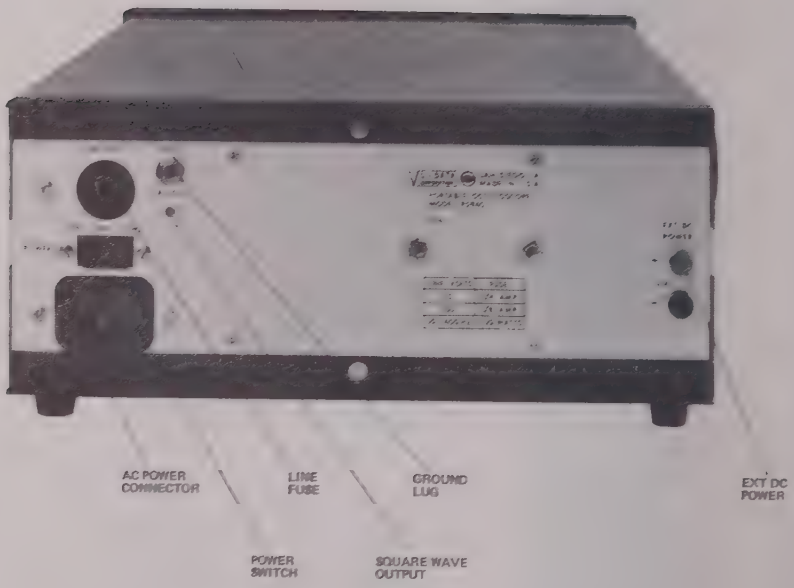


Figure 5-8. Model PS940, Location of Rear Panel Controls

CAUTION

Understand the troubleshooting precautions before attempting to repair or service the instrument. Serious damage to yourself and/or the instrument may result from failure to follow the precautions. When in doubt, contact your local Vu-data representative.

5-19. CALIBRATION

The following procedure provides the information necessary for technical personnel to align and calibrate the Model PS940 Oscilloscope. The alignment should be accomplished at regular periodic intervals to insure the proper operation of the instrument. Since the power supply affects the calibration of the other circuits, it should be calibrated prior to the other sections.

WARNING

When performing instrument calibration, the top and bottom covers must be removed. High voltages, which could be lethal, are accessible and extreme caution should be taken. Screwdrivers with insulated shafts should be used for setting the adjustments. The power should be off while the covers are being removed or installed.

5-20. Test Equipment Required

The following test equipment is required to calibrate the instrument. The model number and manufacturer of the equipment may be substituted provided the specifications of the substituted units are equal to, or better than the listed equipment.

1. Sine Wave Generator — HP Model 651B
2. Square Wave Generator — HP Model 211B
3. Frequency Counter — Fluke Model 1941A
4. Digital Multimeter — Fluke Model 8000A
5. Constant Amplitude Generator — Tektronix Model 191

5-21. Location of Controls for Alignment

Figure 5-1 shows the location of the front panel controls. Figure 5-2 shows the control location for the Vertical Input Board Sub-Assembly. Controls on the Vertical Output Board Sub-Assembly are shown in Figure 5-3. The Horizontal Board controls are shown in Figure 5-4. Figure 5-5 shows the Power Supply Controls. Figure 5-6 shows the control located on the Master Board. Figure 5-7 shows the control location on the Vertical Switch Assembly and Figure 5-8 shows the rear panel controls.

5-22. Power Supply Calibration

Remove the battery pack and AC power line cord. Remove the top and bottom covers. Plug in the power cord and turn on the instrument. Place the trigger mode switch to AUTO and obtain a trace at normal intensity. Connect the digital multimeter between ground and +5 volts at the Elco pins of the Horizontal Board. Adjust the −10V control on the power supply board, R10, until the multimeter reads +5.0V ±.05V. Connect the high lead of the multimeter to the collector of Q6 on the Power Supply Board. (It is easily reached at the top of the board where the strap goes to ceramic capacitor, C26.) Turn off trace intensity. Adjust the high voltage adjust, R24, until the multimeter reads −20V ±1 volt. If a trace cannot be obtained at this point, be sure to recheck this adjustment when a normal trace is visible. The CAL output adjustment will be made after the vertical section has been calibrated.

5-23. Vertical Input, Output, and Master Board Adjustments

5-24. Control Pre-Adjustments

Select CH 1 and adjust the horizontal and CH 1 vertical position controls for a centered sweep. Adjust the FOCUS and INTENSITY for a desired display.

WARNING

A constant trace with maximum intensity may burn the phosphor coating on the cathode ray tube. The warranty on the CRT does not cover phosphor burns.

Set the front panel controls as follows:

1.	AC/DC/Gnd Sw	CH1	GND	CH2	GND
2.	Vertical Attenuator SW	CH1	.01V/Div	CH2	.01V/DIV
3.	Invert/Normal SW	NORMAL			
4.	Trigger Selector	CH 1+2			
5.	Mode SW	CH1			
6.	Trigger Source SW	INT			
7.	Trigger Polarity SW	+			
8.	Trigger Coupling SW	AUTO			
9.	Time/Div SW	1 ms/DIV			

5-25. Vertical Calibration

Turn the vertical vernier knobs fully clockwise for both channels. Connect the multimeter high lead to the arm of CH 1 vernier gain control, R101 (See Figure 5-7), low lead to ground. Adjust U1 offset control, R4, until the multimeter reads zero volts ±0.001 volts. (See Figure 5-2.) Connect the multimeter high lead to the arm of the CH 2 vernier gain control, R201, and adjust U6 offset control, R45, until the multimeter reads zero volts ±0.001 volts. Connect the multimeter high to the arm of the CH 1 position control, R327, and adjust the CH 1 position control until the meter reads zero volts ±0.001 volts. Connect one end of the multimeter to Elco Pin "A" and the other to TP4 and adjust U2 offset control, R13, until there is zero volts ±0.005 volts. Connect one end of the multimeter to Elco Pin "B" and the other end to TP5 and adjust chopper offset, R53, until there is zero volts ±0.005 volts. Switch the mode switch to CH 2. With the multimeter connected as in the last step, adjust U7 offset, R55, to read zero volts ±0.005 volts. Alternate between the last two steps to make sure the chopper offset and U7 offset are balanced. Then switch back to CH 1 and check the U2 offset for DC balance. Connect the high end of the multimeter to Elco Pin "Trig" and the low end to ground. Select Int Ch 1 and observe the voltage. Then select Int Ch 1 and 2 and adjust R40 trigger level control to read the same voltage as in Int Ch 1. Adjust the balance control, R3, on the vertical output board so that the trace is centered vertically on the screen.

Connect the constant amplitude signal generator (Model 191) with a 50 ohm load to the CH 1 input BNC. Set the generator frequency to 50 KHz. Set the CH 1 AC/DC/GND switch to AC. Increase the oscillator amplitude until full scale (eight division) deflection is obtained.

NOTE

The sweep length control, R21, on the horizontal board may be adjusted to obtain a full scale horizontal deflection at this point. Adjust the geometry control, R305, on the master board, so that the top and bottom edges of the display are parallel with the graticule.

Set the generator frequency to 50 KHz and the amplitude to 0.05 V P-P calibrated. Adjust CH 1 cal control, R17 on the vertical input board so that the display measures five vertical divisions. The level control, R7, on the vertical output board may be adjusted if the sine wave shows distortion.

NOTE

The trace angle control, R104, may have to be adjusted to obtain a display which is parallel with the graticule.

Remove the constant amplitude generator from CH 1 and connect it to CH 2 input. Set mode switch to CH 2. Set the CH 2 AC/DC/GND switch to AC. Adjust CH 2 cal, R59, so that the display measures 5 divisions. Set the CH 2 AC/DC/GND switch to the GND position. Check Elco pin "B" and TP5 with the multimeter. Any DC unbalance should be adjusted out, using U7 offset control, R55. Switch the mode switch to CH 1 and check Elco pin "A" and TP4 with the multimeter. Any DC unbalance should be adjusted out, using the chopper offset control, R53.

Turn the mode switch back to CH 2 and place the CH 2 AC/DC/GND switch to the AC position. With the CH 2 vertical position control, move the display to the top five divisions of the graticule and note the vertical amplitude. Then position the display to the bottom portion of the screen. If there is any change in amplitude, adjust the level control, R7, on the vertical output board so that there is no amplitude change with positioning.

Connect a square wave generator to CH 2 input BNC. Set the CH 2 and CH 1 vertical attenuator switches to the 1 VOLT/DIV range. Set the CH 2 AC/DC/GND switch to DC. Adjust the amplitude of the square wave for about four divisions at a frequency of 1 KHz. Adjust the CH 2 attenuator compensation capacitor for the display, as shown in Figure 5-9, Attenuator Compensation. Switch the signal generator to CH 1, select CH 1 and place the CH 1 AC/DC/GND switch to the DC position. Adjust the CH 1 attenuator compensation capacitor for the proper square wave.

Attach probes to the two input BNC's. Set the CH 1 and CH 2 vertical attenuator switches to the 0.5V range. Connect the probes to the square wave generator and adjust the generator amplitude for about a 4 division display. Compensate the CH 1 probe as shown in Figure 5-9. Switch the CH 1 vertical attenuator switch to the 1.0 volt per div. position. Adjust the CH 1 probe compensation capacitor, C103, so that the square wave is compensated. Select CH 2 and repeat the procedure adjusting the CH 2 probe compensation capacitor, C203. Remove the probes.

5-26. Horizontal Board Adjustments

Set the CH 1 and CH 2 AC/DC/GND switches to GND. Using a small screwdriver inserted through the front panel, adjust the trace angle control, R104, so that the trace is parallel to the graticule horizontal centerline. This adjustment should be made with the trace in the vertical center of the screen.

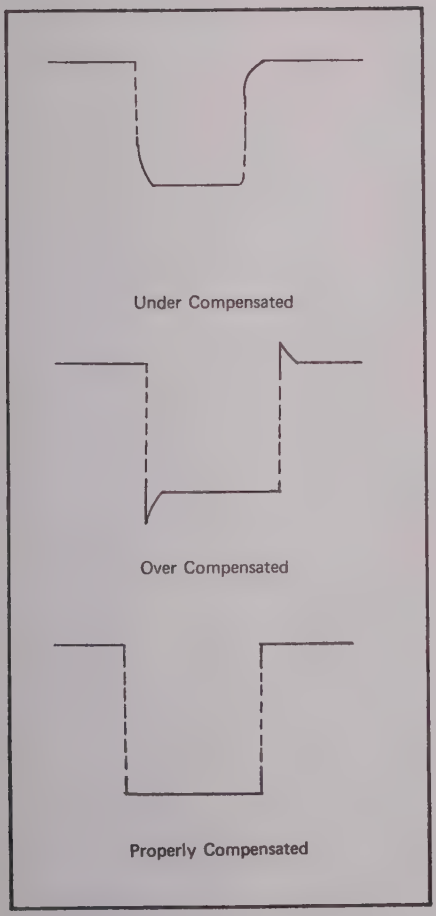
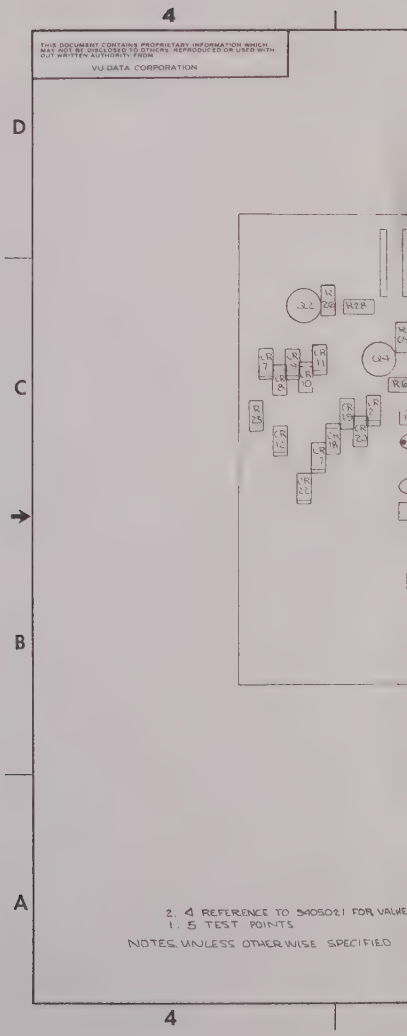


Figure 5-9. Attenuator Compensation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VU DATA CORPORATION
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2. 4 REFERENCE TO 3405021 FOR VALVE
1. 5 TEST POINTS
NOTES, UNLESS OTHERWISE SPECIFIED
4

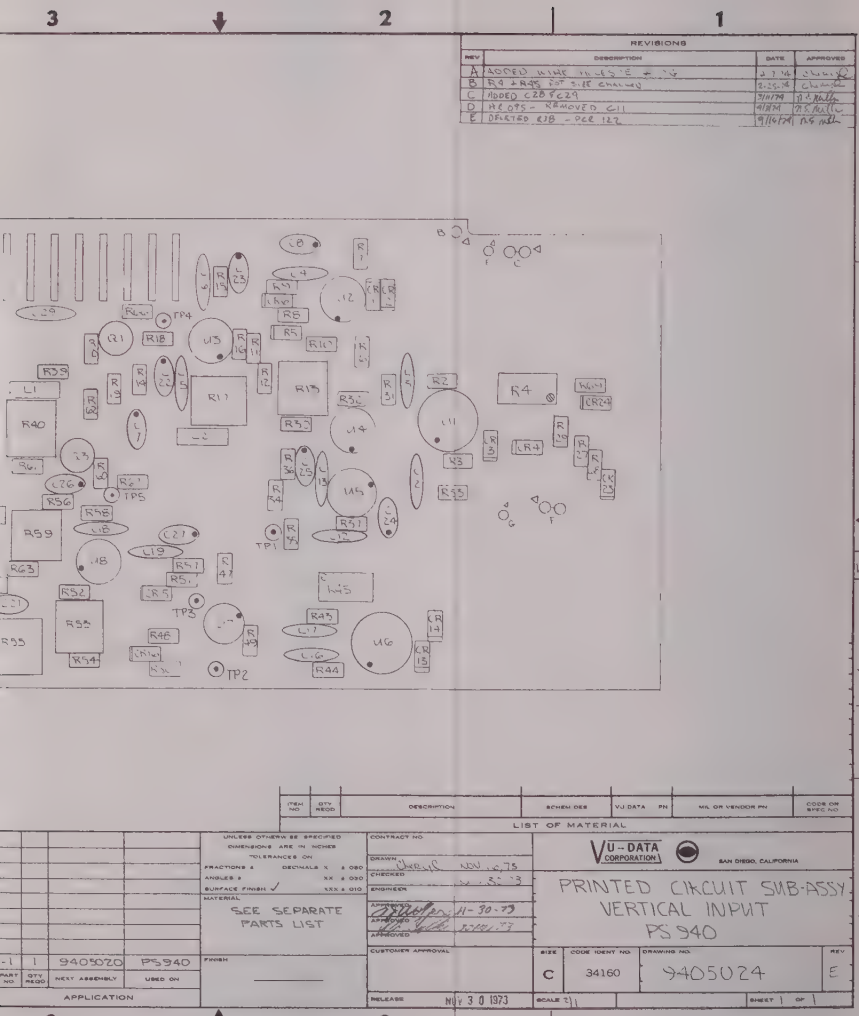

Figure 5-10. Parts Location for Vertical Input Board Sub-Assembly

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NOTES:
- • INDICATES POLARITY
2- * INDICATES FERRITE BEAD ON COLLECTOR LEAD TO BD.
- ↔ Q3
L2 ↔ Q4

				UNLESS OT
				DIMENSION
				TOLE
				FRACTIONS ±
				ANGLES ±
				SURFACE FINISH
				MATERIAL
				SEE SI
				LIST
–		9405029	P5940	FINISH
PART NO.	QTY REQD	NEXT ASSEMBLY	USED ON	
APPLICATION				

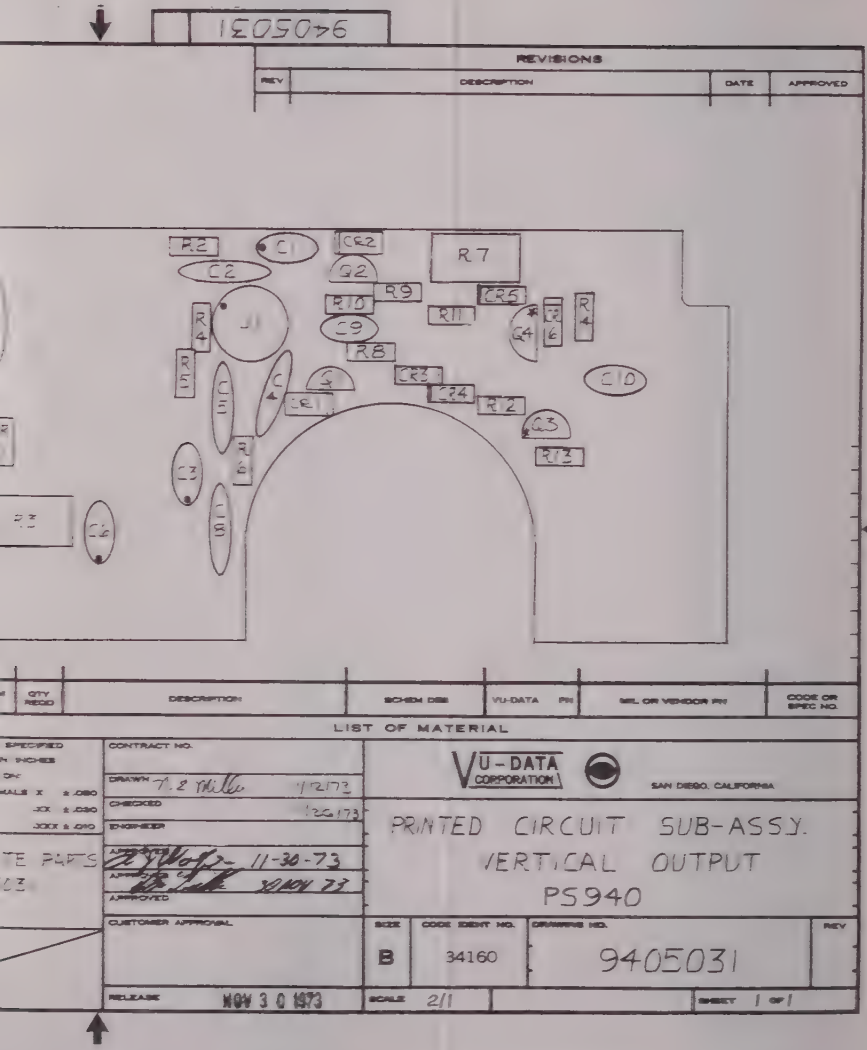

Figure 5-11. Parts Location for Vertical Output Board Sub-Assembly

4
D
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B
A
4

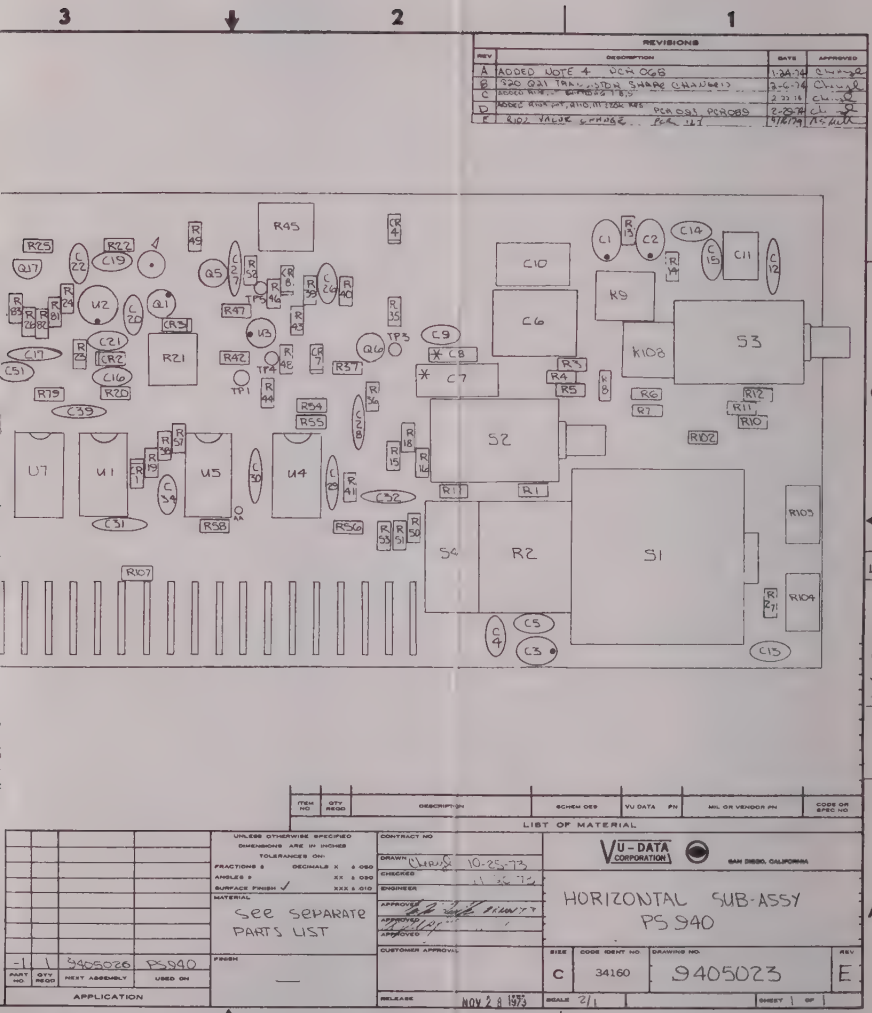
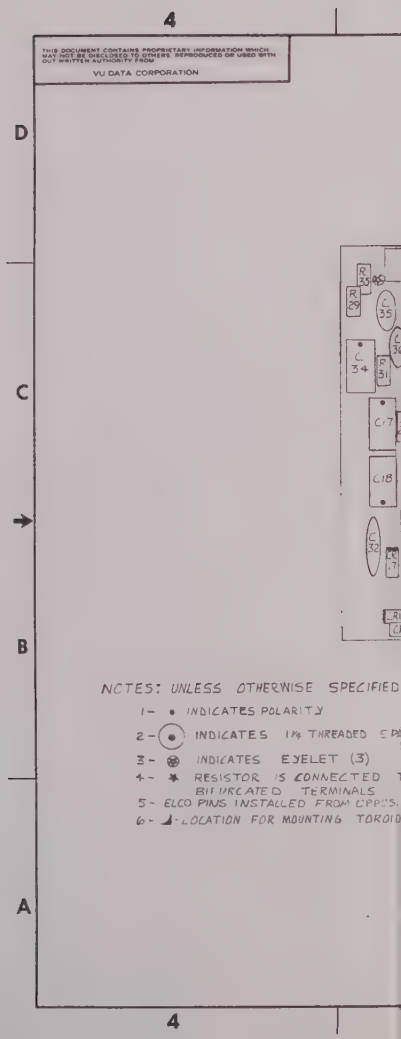


Figure 5-12. Parts Location for Horizontal Board Sub-Assembly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VU DATA CORPORATION
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R 29
C 35
C 34
R 31
C 17
C 18
C 32
NOTES: UNLESS OTHERWISE SPECIFIED
1- • INDICATES POLARITY
2- INDICATES
3- INDICATES EYELET (3)
4- RESISTOR IS CONNECTED
BIFURCATED TERMINALS
5- ELCO PINS INSTALLED FROM
6- LOCATION FOR MOUNTING

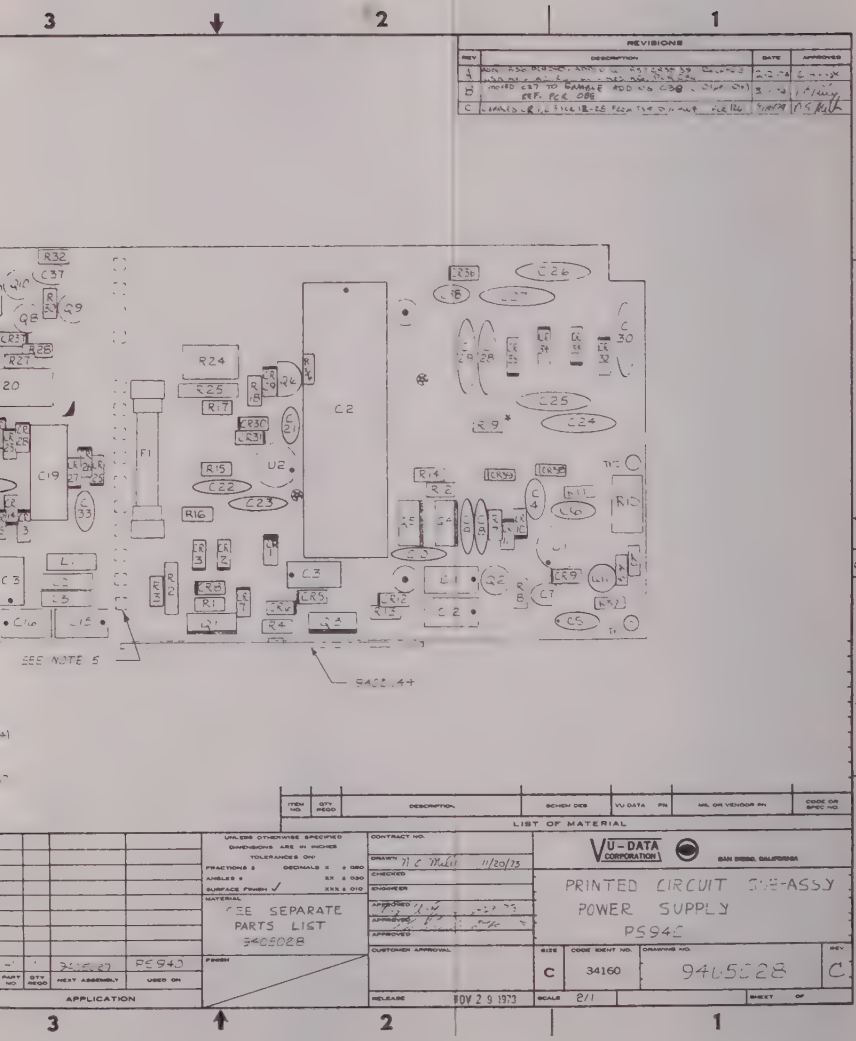
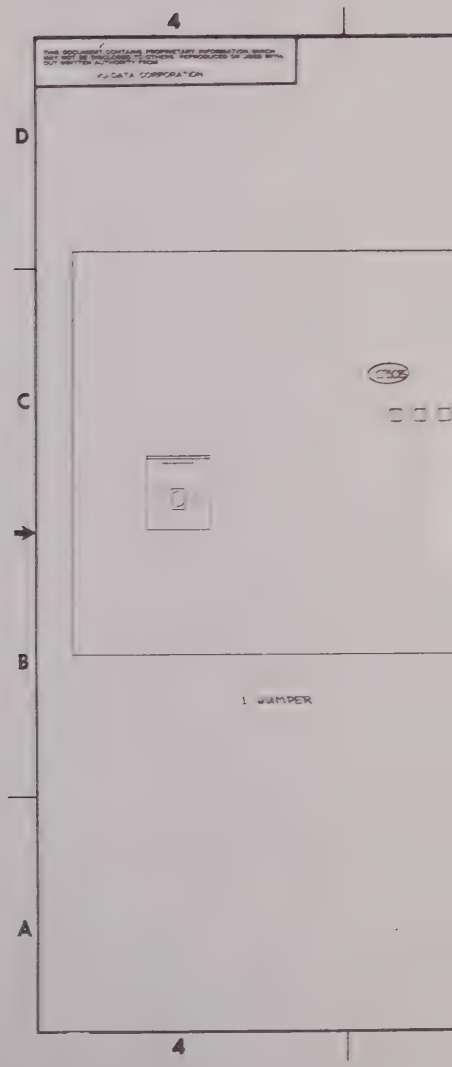


Figure 5-13. Parts Location for Power Board Sub-Assembly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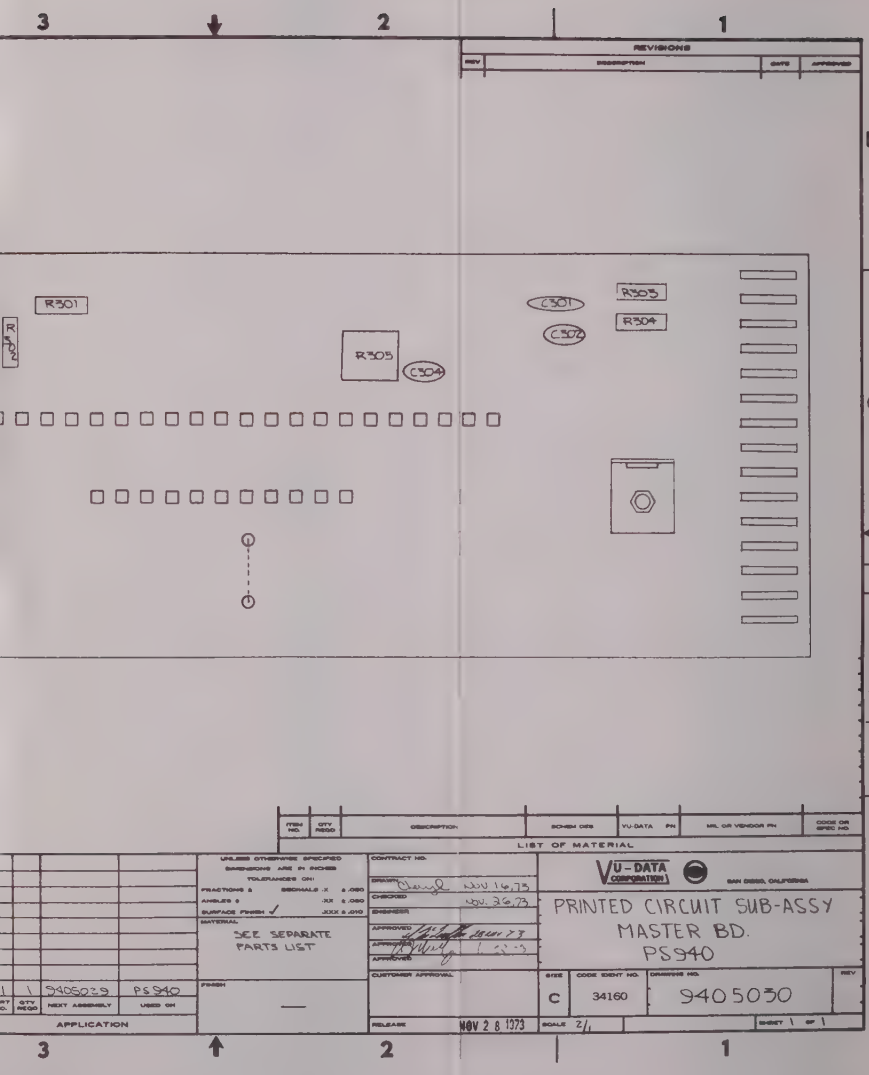


Figure 5-14. Parts Location for Master Board Sub-Assembly

Apply a 1 KHz sine wave to CH 1 input. Set the CH 1 AC/DC/GND switch to AC and adjust the amplitude for eight divisions deflection. With a screwdriver through the front panel, adjust the astigmatism control, R103, in conjunction with the focus control for the sharpest picture.

Connect the frequency counter to the sine wave oscillator and adjust the frequency to 1 KHz ± 1 Hz. Make sure that the time per div switch is in the 1 msec position (red knob pulled out) and the vernier control is in the CW (CAL) position. Adjust the horizontal CAL, R100, such that ten cycles of the sine wave exactly lines up with the 10 vertical lines of the graticule.

Move the right side tenth cycle of the sine wave to the left, to the eighth vertical graticule mark. (Use the horizontal position control.) Adjust sweep length control, R21, so that the sweep ends at the right side graticule mark. This will make the sweep twelve cycles long.

Connect the frequency counter to the sine wave oscillator and adjust the frequency to 1 MHz ± 1Khz. Set the TIME/DIV switch to 1 usec/div. Adjust the fast sweep control, C10, so that the 10 cycles of the sine wave line up with 10 divisions on the graticule. Set the frequency to 5 MHz.

Set the TIM/DIV switch to .1 usec/div. Move the sine wave to the right with the horizontal position control and observe any compression that may be present. Adjust R109 such that you can get as close to five cycles as possible. Then move the display to the left. If there is any tearing on the sine wave at all, adjust R109 to eliminate it. Then position the display to the right again and check linearity.

Connect the frequency counter to the sine wave oscillator and set the frequency to 5 Hz ±.01 Hz. Set the TIME/DIV switch to 200 msec/div. Adjust the slow sweep control, R108, so that 10 cycles line up with the graticule.

Set the oscillator frequency to 2 Hz ±.01 Hz. Set the TIME/DIV switch to 500 msec/div. Adjust the slowest sweep control, R9, so that 10 cycles line up with the graticule.

Set the oscillator frequency to 10 MHz and the TIME/DIV switch to 0.1 usec/div. Set the CH 1 vertical attenuator switch to 0.01 V/div. Reduce the amplitude from the oscillator until the trace just disappears. Adjust U3 offset, R45, so that the trace again appears. Reduce the amplitude further and repeat the adjustment. Leave the oscillator amplitude at a point where the trace is triggered. Switch the trigger selector to INT CH 1 and readjust U3 offset, R45, if required. A slight increase in signal level may be required. Switch the trigger select to INT 1+2 and check that the trace is triggered. If it is not triggered, adjust trigger level, R40, on the vertical input board for a triggered sweep.

5-27. 1.0 Volt Cal Adjustment

Set the CH 1 vertical attenuator switch to 0.2 V/div with the vernier in the CAL position. Connect the CH 1 input to the rear panel Cal output jack. Adjust the TIME/DIV switch for a suitable display. Adjust the Cal Trim Control, R34, on the power supply board for a deflection of five divisions peak-to-peak. This completes the calibration of the instrument. The calibration adjustments should be anchored down with Glyptal, or finger nail polish to preserve the accuracy of the calibration.

Mfg. Code Number	Manufacturer	Location
00853	Sangamo	Marion, Illinois
01121	Allen Bradley	Milwaukee, Wisconsin
01294	Texas Instruments	Dallas, Texas
04062	Elmenco	New York, New York
04713	Motorola	Phoenix, Arizona
05397	Kemet	Cleveland, Ohio
07263	Fairchild	Mt. View, California
12406	Elpac	Fullerton, California
14099	Semtech Corp.	Newbury Park, California
14752	Electrocube	S. Pasadena, California
15818	Amelco	Mt. View, California
24931	Specialty Connector Co., Inc.	Indianapolis, Indiana
26533	Zero	Burbank, California
27556	IBM	Santa Fe Springs, California
28520	Heyman Mfg., Co. (Heyco)	Kenilworth, New Jersey
34160	Vu-data Corp.	San Diego, California
44655	Ohmite Mfg., Co.	Skokie, Illinois
56289	Sprague	North Adams, Massachusetts
71450	CTS	Elkhart, Indiana
71590	Centralab	Milwaukee, Wisconsin
76055	Mallory	Frankfort, Indiana
78488	Stackpole	St. Mary's, Pennsylvania
78553	Tinnerman Products	Cleveland, Ohio
80368	Sylvania	New York, New York
81073	Grayhill	La Grange, Illinois
83330	H. H. Smith	Brooklyn, New York
84171	Arco	Great Neck, New York
86684	RCA	Harrison, New Jersey
87034	Marco-Oak	Anaheim, California
88245	Useco	Van Nuys, California
90201	Mallory	Indianapolis, Indiana
91637	Dale	Columbus, Nebraska
91662	Elco	Willow Grove, Pennsylvania
92219	Waldom	Chicago, Illinois
94222	Southco	Chester, Pennsylvania
95566	Arnold Eng.	Orange, California
99800	Delevan Electric Corp.	Aurora, New York

Table 6-1. PS940 Assemblies

PS940 OSCILLOSCOPE ASSEMBLY 9405033	
ASSEMBLY NUMBER	ASSEMBLY DESCRIPTION
9405020	Vertical Module Assy.
9405021	Vertical Switch Sub-Assy.
9405022	Vertical Front Panel Sub-Assy.
9405024	Vertical Input Sub-Assy.
9405026	Horizontal Module Assy.
9405023	Horizontal Board Sub-Assy.
9405025	Horizontal Front Panel Sub-Assy.
9405027	Power Supply Assy.
9405028	Power Supply Board Sub-Assy.
9405029	Display Assy.
9405030	Master Board Sub-Assy.
9405031	Vertical Output Sub-Assy.

Table 6-2. Parts List (Vertical Module Assembly 9405020)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9405022	Front Panel Sub-Assy-Vert.	34160	
	9405024	Vertical Bd. Sub-Assy.	34160	
2 Req	9405021	Vertical Sw. Sub-Assy.	34160	
2 Req	9402039	Vertical Sw. Bracket	34160	1-10629
	9402053	Bracket, Vert. Position Pot	34160	1-10636
	9402055	Shaft, Vert. Position Pot	34160	
R326	RV6NAYSD101B	Res. Var 100 ohm Carbon	01121	5-76101
C301,305	625B1E104K	Cap, Mylar, .1 uf,400V ±10%	14752	6-59104
CR301,302	1N914	Diode, GP, 1N914	07263	3-10914
R310,323	RC07GF100J	Res,CC,10 ohm, ¼W, 5%	01121	5-10100
2 Req	023-352	Knob Black, ¼" Shaft	Elma	4-10013
2 Req	021-123	Knob, Red, 1/8" Shaft	Elma	4-10009
2 Req	040-103	Knob, Cap, Red	Elma	4-10010
2 Req	044-202	Decorative Nut Cover	Elma	4-10019
	021-222	Knob, Black, 1/8" Shaft	Elma	4-10011
	040-102	Knob, Cap Black	Elma	4-10012
	180	1/8" Shaft Coupler	83330	
2 Req	MS51957-15	Screw, Pan Head, 4-40 x 3/8		
	MS24693-2	Screw, 100° Flat 4-40 x 1/4		

Table 6-3. Parts List (Vertical Switch Sub-Assembly 9405021)

REFERENCE DESIGNATOR		MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO
CH 1	CH 2				
S101	S201	9402029	Switch – Vertical	34160	2-10036
			CAPACITORS		
C111	C211	DM15FD050J03	DM, 5 pf ± 1 pf, 500V	04062	6-19050
C102	C202	PC400	Var, Mica, 2-8 Pf	04062	6-96000
C103	C203	PC402	Var, Mica, 5.5-18 pf	04062	6-96001
C104	C204	DM15ED331J03	DM, 330 pf ± 5%, 500V	04062	6-19331
C109	C209	CM105FD471J03	DM, 470 pf ± 5%, 500V	00853	6-19471
			RESISTORS		
R108	R208	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R107	R207	RN55D13R3F	MF, 13.3 ohm, 1/8W, 1%	91637	5-51012
R106	R206	RN55D20R0F	MF, 20.0 ohm, 1/8W, 1%	91637	5-51029
R105	R205	RN55D34R0F	MF, 34.0 ohm, 1/8W, 1%	91637	5-51051
R104	R204	RN55D64R9F	MF, 64.9 ohm, 1/8W, 1%	91637	5-51078
R103	R203	RN55D2000F	MF, 200 ohm, 1/8W, 1%	91637	5-51125
R102	R202	RN55D3320F	MF, 332 ohm, 1/8W, 1%	91637	5-51146
R122	R222	RN55D1022F	MF, 10.2K ohm, 1/8W, 1%	91637	5-51300
R109	R209	RN60D1004F	MF, 1M ohm, 1/8W, 1%	91637	5-50490
R125	R225	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R127	R227	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R123	R223	RN60D1004F	MF, 1M ohm, 1/8W, 1%	91637	5-50490
L101	L201	.115 x .125	Ferrite Bead	Amidon	5-90001

Table 6-4. Parts List (Vertical Front Panel Sub-Assembly 9405022)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9402032	Front Panel, Vertical	34160	1-10622
	9402038	Bracket, Front Panel	34160	1-10628
S305,306	7211	Switch, Toggle	C & K	2-10002
S308	7101	Switch, Toggle	C & K	2-10003
S307	7201	Switch, Toggle	C & K	2-10015
R327	RV6NAYSD252B	Res,Var, 2.5K Carbon	01121	5-76252
J301,302	31-221-1015	BNC Connector, UG1094/u	Amphenol	2-28998
	184	Panel Bearing, 1/8" Shaft	83330	4-20120
	021-222	Knob, Black, 1/8" Shaft	Elma	4-10011
	040-102	Cap, Black	Elma	4-10012

Table 6-5. Parts List (Horizontal Sub-Assembly 9405023)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9403023	Etch Circuit Bd.	34160	1-20071
		CAPACITORS		
C1	T362C106M035AS	Tant, 10 uf ±20%, 35V	05397	6-75106
C2	T362B227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C3	T362B225M035AS	Tant, 2.2 uf ±20%, 35V	05397	6-75225
C4	DDM-503	CD, .05 uf +60 -40%, 100V	71590	6-27503
C5	DM15FD471J03	DM, 470 pf ±5%, 500V	04062	6-19471
C6	65B1A205	MM, 2 uf ±5%, 50V	14752	6-46205
C7	9002070	MM, 1 uf, 50V } Matched	34160	6-56003
C8	9002070	MM, .01 uf, 50V } Set	34160	6-56003
C9	DM15ED820J03	DM, 82 pf ±5%, 500V	04062	6-19820
C10	PC402	Var, Mica, 1.5-20 pf	04062	6-96001
C11	XP2A474J	MM, .47 uf ±10%, 50V	IMB	6-46474
C12	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C13	DM15FD331J03	DM, 330 pf ±5%, 500V	04062	6-19331
C14	DD272CRL	CD, .0027 uf +60 -40%, 1KV	71590	6-20272
C15	DM15ED101J03	DM, 100 pf ±5%, 500V	04062	6-19101
C16	DM15FD221J03	DM, 220 pf ±5%, 500V	04062	6-19221
C17	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C18				
C19	DM15CD100K03	DM, 10 pf ±5%, 500V	04062	6-19100
C20	DM15ED470J03	DM, 47 pf ±5%, 500V	04062	6-19470
C21	DM15ED820J03	DM, 82 pf ±5%, 500V	04062	6-19820
C22	DDM-503	CD, .05 uf +60 -40%, 100V	71590	6-27503
C23	DM15ED330J03	DM, 33 pf ±5%, 500V	04062	6-19330
C24	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C25	DM15ED330J03	DM, 33pf ±5%, 500V	04062	6-19330
C26	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C27	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C28	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C29	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C30	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C31	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C32	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C33	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C34	DM15ED470J03	DM, 47 pf ±5%, 500V	04062	6-19470
C35	DM15ED330J03	DM, 33 pf ±5%, 500V	04062	6-19330
C36	CM05FD331J03	DM, 330 pf ±5%, 500V	04062	6-19331
C37	DM15ED330J03	DM, 33 pf ±5%, 500V	04062	6-19330
C38	CM05FD331J03	DM, 330 pf ±5%, 500V	04062	6-19331

Table 6-5. Parts List (Horizontal Sub-Assembly 9405023) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
C39	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C40	DM15ED820-J03	DM, 82pf ±5%, 500V	04062	6-19820
C41	T362D337M006AS	Tant, 330 uf ±20%, 6V	05397	6-71337
C42	T362C106M035AS	Tant, 10 uf ±20%, 35V	05397	6-75106
C43	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C44	T362B225M035AS	Tant, 2.2 uf ±20%, 35V	05397	6-75225
C45	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C46	DDM-503	CD, .05 uf ±20%, 100V	71590	6-27503
C47	DDM-503	CD, .05 uf ±20%, 100V	71590	6-27503
C48	T362D337M006AS	Tant, 330 uf ±20%, 6V	05397	6-71337
C49	DDM-503	CD, .05 uf ±20%, 500V	71590	6-27503
C50-N	DM15CD180K03	DM, 18 pf ±5%, 500V	04062	6-19180
C51	DDM-503	CD, .05 uf ±20%, 500V	71590	6-27503
C52	DDM-503	CD, .05 uf ±20%, 500V	71590	6-27503
C53	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C54	DM15FD151J03	DM, 150 pf ±5%, 500V	04062	6-19151
		CHOKES		
L1	70F102A1	10 mHy	99800	5-90005
L2	70F102A1	10 mHy	99800	5-90005
		DIODES		
CR1	1N914	GP, 1N914	07263	3-10914
CR2	1N914	GP, 1N914	07263	3-10914
CR3	1N967B	Zener, 18V	04713	3-10967B
CR4	1N914	GP, 1N914	07263	3-10914
CR5				
CR6				
CR7	1N914	GP, 1N914	07263	3-10914
CR8	1N914	GP, 1N914	07263	3-10914
CR9	1N914	GP, 1N914	07263	3-10914
CR10	1N914	GP, 1N914	07263	3-10914
CR11	1N914	GP, 1N914	07263	3-10914
CR12	1N914	GP, 1N914	07263	3-10914
CR13	1N914	GP, 1N914	07263	3-10914
CR14	1N914	GP, 1N914	07263	3-10914
CR15	1N914	GP, 1N914	07263	3-10914
CR16	1N914	GP, 1N914	07263	3-10914
CR17	1N4447	GP, 1N4447	07263	3-14447

Table 6-5. Parts List (Horizontal Sub-Assembly 9405023) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR18	1N4447	GP, 1N4447	07263	3-14447
CR19	1N914	GP, 1N914	07263	3-10914
CR20	1N914	GP, 1N914	07263	3-10914
CR21	1N4447	GP, 1N4447	07263	3-14447
CR22	1N4447	GP, 1N4447	07263	3-14447
	02-024-013-5-200	Elco Pin Strip	Elco	
		INTEGRATED CIRCUITS		
U1	SN74L122N	One-shot, SN74L122N	01294	3-3122N
U2	RC4531T	Op, Amp, RC4531T	Raytheon	3-34531
U3	FD1673	Dual FET, FD1673	Solitron	3-21673
U4	U6A7760393	Comp, 760	07263	3-37760
U5	SN7451N	Gate, SN7451N	01294	3-37451
U6	SN7476N	Flip-Flop, SN7476	01294	3-37476
U7	SN7451N	Gate, SN7451N	01294	3-37451
		RESISTORS		
R1	RC07GF272J	CC, 2.7K ohm, ¼W, 5%	01121	5-10272
R2		Reference S1		
R3	RN55D4991F	MF, 4.99K ohm, 1/8W, 1%	91637	5-51270
R4	RN55D2492F	MF, 24.9K ohm, 1/8W, 1%	91637	5-51337
R5	RN55D8252F	MF, 82.5K ohm, 1/8W, 1%	91637	5-51386
R6	RN55D2493F	MF, 249K ohm, 1/8W, 1%	91637	5-51432
R7	RN55D2003F	MF, 200K ohm, 1/8W, 1%	91637	5-51423
R8	RN60D5763F	MF, 576K ohm, 1/8W, 1%	91637	5-50467
R9	360T254B	Var Cer, 250K ohm	71450	5-73254
R10	RN55D1243F	MF, 124K ohm, 1/8W, 1%	91637	5-51403
R11	RN55D2492F	MF, 24.9K ohm, 1/8W, 1%	91637	5-51337
R12	RN55D4991F	MF, 4.99K ohm, 1/8W, 1%	91637	5-51270
R13	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R14	RC07GF273J	CC, 27K ohm, ¼W, 5%	01121	5-10273
R15	RC07GF223J	CC, 22K ohm, ¼W, 5%	01121	5-10223
R16	RC07GF223J	CC, 22K ohm, ¼W, 5%	01121	5-10223
R17	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R18	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R19	RC07GF223J	CC, 22K ohm, ¼W, 5%	01121	5-10223
R20	RC07GF332J	CC, 3.3K ohm, ¼W, 5%	01121	5-10332
R21	360T502B	Var, Cer. 5K ohm	71450	5-73502
R22	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472

Table 6-5. Parts List (Horizontal Sub-Assembly 9405023) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R23	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R24	RC07GF392J	CC, 3.9K ohm, ¼W, 5%	01121	5-10392
R25	RC07GF561J	CC, 560 ohm, ¼W, 5%	01121	5-10561
R26	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R27	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R28	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R29	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R30	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R31	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R32	RC07GF331J	CC, 330 ohm, ¼W, 5%	01121	5-10331
R33	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R34	RC07GF564J	CC, 560K ohm, ¼W, 5%	01121	5-10564
R35	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R36	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R37	RC07GF223J	CC, 22K ohm, ¼W, 5%	01121	5-10223
R38	RC07GF471J	CC, 470 ohm, ¼W, 5%	01121	5-10471
R39	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R40	RC07GF105J	CC, 1M ohm, ¼W, 5%	01121	5-10105
R41	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R42	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R43	RC07GF272J	CC, 2.7K ohm, ¼W, 5%	01121	5-10272
R44-N*	RC07GF181J	CC, 180 ohm, ¼W, 5%	01121	5-10181
R45	360T501B	Var, Cer. 500 ohm	71450	5-73501
R46	RC07GF272J	CC, 2.7K ohm, ¼W, 5%	01121	5-10272
R47	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R48-N*	RC07GF181J	CC, 180 ohm, ¼W, 5%	01121	5-10181
R49	RC07GF682J	CC, 6.8K ohm, ¼W, 5%	01121	5-10682
R50	RC07GF512J	CC, 5.1K ohm, ¼W, 5%	01121	5-10512
R51	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R52	RC07GF104J	CC, 100K ohm, ¼W, 5%	01121	5-10104
R53	RC07GF512J	CC, 5.1K ohm, ¼W, 5%	01121	5-10512
R54	RC07GF104J	CC, 100K ohm, ¼W, 5%	01121	5-10104
R55	RC07GF104J	CC, 100K ohm, ¼W, 5%	01121	5-10104
R56	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R57	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R58	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R59	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R60	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R61	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R62	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R63	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R64	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R65	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102

*N means nominal value

Table 6-5. Parts List (Horizontal Sub-Assembly 9405023) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO
R66	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R67	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R68	RC07GF561J	CC, 560 ohm, ¼W, 5%	01121	5-10561
R69	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R70	RC07GF222J	CC, 2.2K ohm, ¼W, 5%	01121	5-10222
R71	RN55D6491F	MF, 6.49K ohm, 1/8W, 1%	91637	5-51281
R72	RC07GF391J	CC, 390 ohm, ¼W, 5%	01121	5-10391
R73	RN55D1001F	MF, 1K ohm, 1/8W, 1%	91637	5-51193
R74	RN55D1001F	MF, 1K ohm, 1/8W, 1%	91637	5-51193
R75	RN55D2553F	MF,255K ohm,1/8W, 1%	91637	5-51433
R76	RN55D1503F	MF,150K ohm,1/8W, 1%	91637	5-51411
R77	RN55D1102F	MF, 11K ohm, 1/8W, 1%	91637	5-51303
R78	RN55D6192F	MF, 61.9K ohm,1/8W, 1%	91637	5-51374
R79	RC07GF273J	CC, 27K ohm, ¼W, 5%	01121	5-10273
R80	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R81	RN55D1001F	MF, 1K ohm, 1/8W, 1%	91637	5-51193
R82	RN55D1212F	MF, 12.1K ohm, 1/8W, 1%	91637	5-51307
R83	RN55D1213F	MF, 121K ohm,1/8W, 1%	91637	5-51402
R84	RC07GF154J	CC, 150K ohm, ¼W, 5%	01121	5-10154
R85	RC07GF824J	CC, 820K ohm, ¼W, 5%	01121	5-10824
R86	RN55D4992F	MF, 49.9K ohm,1/8W, 1%	91637	5-51366
R87	RC07GF183J	CC, 18K ohm, ¼W, 5%	01121	5-10183
R88	RC07GF183J	CC, 18K ohm, ¼W, 5%	01121	5-10183
R89-N	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R90	RC07GF153J	CC, 15K ohm, ¼W, 5%	01121	5-10153
R91	RC07GF183J	CC, 18K ohm, ¼W, 5%	01121	5-10183
R92	RN55D9310F	MF, 931 ohm, 1/8W, 1%	91637	5-51190
R93	RC07GF183J	CC, 18K ohm, ¼W, 5%	01121	5-10183
R94	RCR32GF393J	CC, 39Kohm, 1W, 5%	01121	5-30393
R95	RCR32GF393J	CC, 39K ohm, 1W, 5%	01121	5-30393
R96	RC07GF824J	CC, 820K ohm, ¼W, 5%	01121	5-10824
R97	RC07GF154J	CC, 150K ohm, ¼W, 5%	01121	5-10154
R98	RN55D4992F	MF, 49.9K ohm, 1/8W, 1%	91637	5-51366
R99	RC07GF183J	CC, 18K ohm, ¼W, 5%	01121	5-10183
R100	360T254B	Var, Cer, 250K ohm	71450	5-73254
R101	RC07GF153J	CC, 15K ohm, ¼W, 5%	01121	5-10153
R102	RC07GF331J	CC, 330 ohm, ¼W, 5%	01121	5-10331
R103	360T254B	Var, Cer. 250K ohm	71450	5-73254
R104	360T502B	Var, Cer, 5K ohm	71450	5-73502
R105	RC07GF471J	CC, 470 ohm, ¼W, 5%	01121	5-10471
R106	RC07GF220J	CC, 22 ohm, ¼W, 5%	01121	5-10220
R107	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R108	360T104B	Var Cer, 100K ohm	71450	5-73104

Table 6-6. Parts List (Vertical Input Sub-Assembly 9405024)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9403024	Etched Circuit Bd.	34160	1-20068
		CAPACITORS		
C1				
C2	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C3	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C4	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C5	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C6	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C7	T362D107M020AS	Tant, 100 uf ±20%, 20V	05397	6-74107
C8	T362D107M020AS	Tant, 100 uf ±20%, 20V	05397	6-74107
C9				
C10				
C11				
C12	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C13	UK20-104	CD, .1 uf +80-20%, 20V	71590	6-24104
C14	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C15				
C16	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C17	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C18	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C19	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C20	T362D107M020AS	Tant, 100 uf ±20%, 20V	05397	6-74107
C21	T362D107M020AS	Tant, 100 uf ±20%, 20V	05397	6-74107
C22	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C23	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C24	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C25	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C26	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C27	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C28	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C29	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
		CHOKES		
L1	1537-76	100 uHy	99800	5-90007
L2	1537-76	100 uHy	99800	5-90007
L3	1537-76	100 uHy	99800	5-90007
L4	1537-76	100 uHy	99800	5-90007
		DIODES		
CR1	1N914	GP, 1N914	07263	3-10914
CR2	1N914	GP, 1N914	07263	3-10914

Table 6-6. Parts List (Vertical Input Sub-Assembly 9405024) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR3	SE325	GP, SE325	GE	3-10300
CR4	SE325	GP,SE325	GE	3-10300
CR5	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR6	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR7	1N914	GP, 1N914	07263	3-10914
CR8	1N914	GP, 1N914	07263	3-10914
CR9	1N914	GP, 1N914	07263	3-10914
CR10	1N914	GP, 1N914	07263	3-10914
CR11	1N914	GP, 1N914	07263	3-10914
CR12	1N914	GP, 1N914	07263	3-10914
CR13	SE325	GP, 325	GE	3-10300
CR14	SE325	GP, 325	GE	3-10300
CR15	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR16	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR17	1N914	GP, 1N914	07263	3-10914
CR18	1N914	GP, 1N914	07263	3-10914
CR19	1N914	GP, 1N914	07263	3-10914
CR20	1N914	GP, 1N914	07263	3-10914
CR21	1N914	GP, 1N914	07263	3-10914
CR22	1N914	GP, 1N914	07263	3-10914
CR23	1N914	GP, 1N914	07263	3-10914
CR24	1N914	GP, 1N914	07263	3-10914
	02-011-013-5-200	Elco Pin Strip	Elco	
		INTEGRATED CIRCUITS		
U1	LH0033C	Amp, LH0033C	Nat'l	3-30033
U2	CA3018	Amp, CA3018	86684	3-33018
U3	U5F7733393	Amp, 733	07263	3-30733
U4	CA3018	Amp, CA3018	86684	3-33018
U5	U5F7733393	Amp, 733	07263	3-30733
U6	LH0033C	Amp, LH0033C	Nat'l	3-30033
U7	CA3018	Amp, CA3018	86684	3-33018
U8	U5F7733393	Amp, 733	07263	3-30733

Table 6-7. Parts List (Horizontal Front Panel Sub-Assembly 9405025)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9402031	Front Panel, Horizontal	34160	1-10621
	9402050	Horizontal Module Bkt.	34160	1-10634
S201,202	7101	Switch, Toggle	C & K	2-10003
R204,205	MLC-505	Res,Var, 5 Meg Carbon	Mallory	5-78505
R203,206	MLC-54L	Res, Var, 50K Carbon	Mallory	5-77513
J201	31-221-1015	BNC Connector UG1094/u	Amphenol	2-28998
4 Req.	021-222	Knob, Black, 1/8" Shaft	Elma	4-10011
4 Req.	040-102	Cap, Black	Elma	4-10012

Table 6-8. Parts List (Horizontal Module Assembly 9405026)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9405025	Front Panel Sub-Assy-Horz.	34160	
	9405023	Horizontal Bd. Sub-Assy.	34160	
	9402046	Shaft, Mode Switch	34160	
C201	DM15FD050J03	Cap, DM, 5 pf ±1 pf, 500V	04062	6-19050
DS201	XC209G	Indicator Light	Xciton	3-10210
R201	RC07GF684J	Res, CC,680K ohm,¼W,5%	01121	5-10684
R202	RC07GF334J	Res, CC,330K ohm,¼W,5%	01121	5-10334
	180	Shaft Coupler	83330	4-20003
	023-352	Knob, Black, ¼" Shaft	Elma	4-10013
	021-123	Knob, Red, 1/8" Shaft	Elma	4-10009
	040-103	Knob Cap, Red	Elma	4-10010
2 Req.	021-222	Knob, Black, 1/8" Shaft	Elma	4-10011
2 Req.	040-102	Knob Cap, Black	Elma	4-10012

Table 6-9. Parts List (Power Supply Assembly 9405027)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9405028	Power Supply Bd. Sub-Assy.	34160	
T201	9402001	Power Transformer	34160	7-61010
	9402041	Fuse Bracket	34160	1-10631
	9402033	Rear Panel	34160	1-10623
	9402056	Power Supply Shield	34160	
J201	EAC-301	AC Power Receptacle	Switchcraft	2-24000
S202	46206LFR	Slide Switch, 115/230	Switchcraft	2-10025
S201	7203 W/ J Rocker	Switch, DPTT	C & K	2-10031
XF201	HMM	Fuse Holder	Buss	2-40007
F201	3AG.25ASB	Fuse, 1/4A Slo Blo	Buss	2-40004
J204	63-1000-101	Test Jack, White	83330	2-50009
	195	Miniature Banana Jack	83330	
4 Req.	8328	Spacer - 4-40 x 1 1/4	83330	
4 Req.	8766	Spacer - 4-40 x 5/16	83330	
	1410-4	Terminal Lug, No. 4 Int.Lk	83330	
J202	2142-0	Banana Jack - Black	Pomona	4-20157
J203	2142-2	Banana Jack - Red	Pomona	4-20158
2 Req.	8700	Spacer, 1/8" L	83330	
7 Req.	MS51957-15	Screw, Pan Head, 4-40 x 3/8"		
4 Req.	MS51957-21	Screw, Pan Head, 4-40 x 1"		
11 Req.	MS24693-4	Screw, 100° Flat, 4-40 x 3/8"		
13 Req.	MS35333-70	Lockwasher, No. 4 Internal		
4 Req.	NAS671C4	Nut, 4-40, Plain Hex		

Table 6-10. Parts List (Power Supply Sub-Assembly 9405028)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9403028	Etched Circuit Bd.	34160	1-20072
		CAPACITORS		
C1				
C2	601D108G025GL4	Elect, 1000 uf, 25V	56289	6-84102
C3	T362D107M020AS	Tant, 100 uf ±20%, 20V	05397	6-74107
C4	DDM-503	CD, .05 uf ±20%, 100V	71590	6-27503
C5	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C6	DDM-503	CD, .05 uf ±20%, 100V	71590	6-27503
C7	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C8	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C9	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C10	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C11	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C12	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C13	T362D337M006AS	Tant, 330 uf ±20%, 6V	05397	6-71337
C14	T362D337M006AS	Tant, 330 uf ±20%, 6V	05397	6-71337
C15	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C16	T362D227M010AS	Tant, 220 uf ±20%, 10V	05397	6-76227
C17	T362D476M035AS	Tant, 47 uf ±20%, 35V	05397	6-75476
C18	T362D476M035AS	Tant, 47 uf ±20%, 35V	05397	6-75476
C19	ZD2A105K	MM, 1 uf ±20%, 100V	14752	6-47105
C20	ZD2A105K	MM, 1 uf ±20%, 100V	14752	6-47105
C21	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C22	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C23	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C24	5HK-P10	CD, .1 uf ±20%, 500V	56289	6-29103
C25	5HK-P10	CD, .1 uf ±20%, 500V	56289	6-29103
C26	30GAS10	CD, .01 uf ±20%, 3KV	56289	6-29104
C27	30GAS10	CD, .01 uf ±20%, 3KV	56289	6-29104
C28	30GAS10	CD, .01 uf ±20%, 3KV	56289	6-29104
C29	30GAS10	CD, .01 uf ±20%, 3KV	56289	6-29104
C30	30GAS10	CD, .01 uf ±20%, 3KV	56289	6-29104
C31	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C32	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C33	5HK-D50	CD, .005 uf ±20%, 500V	56289	6-29502
C34	T362D686M006AS	Tant, 68 uf ±20%, 6V	05937	6-71686
C35	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C36	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103
C37	DM15CD180K03	DM, 18 pf ±5%, 500V	04062	6-19180
C38	DDM-103	CD, .01 uf +60 -40%, 150V	71590	6-27103

Table 6-10. Parts List (Power Supply Sub-Assembly 9405028) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
		CHOKES		
L1	15537-76	100 uHy	99800	5-90007
L2	15537-76	100 uHy	99800	5-90007
L3	15537-76	100 uHy	99800	5-90007
		DIODES		
CR1*	1N4004	Power, 1A, 400V	07263	3-14004
CR2*	1N4004	Power, 1A, 400V	07263	3-14004
CR3*	1N4004	Power, 1A, 400V	07263	3-14004
CR4				
CR5	1N965B	Zener, 15V	04713	3-10965
CR6	1N914	GP, 1N914	07263	3-10914
CR7	1N914	GP, 1N914	07263	3-10914
CR8	1N914	GP, 1N914	07263	3-10914
CR9	1N5232A	Zener, 5.6V	04713	3-15232
CR10	1N914	GP, 1N914	07263	3-10914
CR11	1N914	GP, 1N914	07263	3-10914
CR12*	1N4004	Power, 1A, 400V	07263	3-14004
CR13*	1N4004	Power, 1A, 400V	07263	3-14004
CR14*	1N4004	Power, 1A, 400V	07263	3-14004
CR15*	1N4004	Power, 1A, 400V	07263	3-14004
CR16*	1N4004	Power, 1A, 400V	07263	3-14004
CR17*	1N4004	Power, 1A, 400V	07263	3-14004
CR18*	1N4004	Power, 1A, 400V	07263	3-14004
CR19*	1N4004	Power, 1A, 400V	07263	3-14004
CR20*	1N4004	Power, 1A, 400V	07263	3-14004
CR21*	1N4004	Power, 1A, 400V	07263	3-14004
CR22*	1N4004	Power, 1A, 400V	07263	3-14004
CR23*	1N4004	Power, 1A, 400V	07263	3-14004
CR24*	1N4004	Power, 1A, 400V	07263	3-14004
CR25*	1N4004	Power, 1A, 400V	07263	3-14004
CR26*	1N4004	Power, 1A, 400V	07263	3-14004
CR27*	1N4004	Power, 1A, 400V	07263	3-14004
CR28*	1N4004	Power, 1A, 400V	07263	3-14004
CR29*	1N4004	Power, 1A, 400V	07263	3-14004
CR30	1N914	GP, 1N914	07263	3-10914
CR31	1N914	GP, 1N914	07263	3-10914
CR32	SCM40	Rect. SCM40	14099	3-10350
CR33	SCM40	Rect. SCM40	14099	3-10350
CR34	SCM40	Rect. SCM40	14099	3-10350

*Only acceptable manufacturer is Fairchild.

Table 6-10. Parts List (Power Supply Sub-Assembly 9405028) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR35	SCM40	Rect, SCM40	14099	3-10350
CR36	1N982B	Zener, 75V	04713	3-10982
CR37	1N914	GP, 1N914	07263	3-10914
CR38	1N914	GP, 1N914	07263	3-10914
CR39	1N914	GP, 1N914	07263	3-10914
	02-015-113-3-200	Elco Pin Strip	Elco	
F1	3AG15APT	Fuse, 1.5 Amp, FB	Littlefuse	2-40013
		INTEGRATED CIRCUITS		
U1	LM301A	Amp, LM301A	Nat'l	3-30301
U2	LM301A	Amp, LM301A	Nat'l	3-30301
		RESISTORS		
R1	RC07GF331J	CC, 330 ohm, ¼W, 5%	01121	5-10331
R2		TBD		
R3	RC07GF3R3J	CC, 3.3 ohm, ¼W, 5%	01121	5-10033
R4		TBD		
R5				
R6	RC07GF152J	CC, 1.5K ohm, ¼W, 5%	01121	5-10152
R7	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R8	RC07GF471J	CC, 470 ohm, ¼W, 5%	01121	5-10471
R9	RN55D1652F	MF, 16.5K ohm, 1/8W, 1%	91637	5-51391
R10	360T103B	Var, Cer, 10K ohm	71450	5-73103
R11	RN55D1002F	MF, 10K ohm, 1/8W, 1%	91637	5-51299
R12	RC07GF331J	CC, 330 ohm, ¼W, 5%	01121	5-10331
R13	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102
R14	RC07GF331J	CC, 330 ohm, ¼W, 5%	01121	5-10331
R15	RC07GF100J	CC, 10ohm, ¼W, 5%	01121	5-10100
R16	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R17	RC07GF273J	CC, 27K ohm, ¼W, 5%	01121	5-10273
R18	RC07GF562J	CC, 5.6K ohm, ¼W, 5%	01121	5-10562
R19	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R20				
R21				
R22				
R23				
R24	360T105B	Var, Cer, 1M ohm	71450	5-73105
R25	RC20GF105JS	CC, 1M ohm, ½W, 5%	01121	5-20105

Table 6-10. Parts List (Power Supply Sub-Assembly 9405028) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO
R26	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R27	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5 10472
R28	RC07GF823J	CC, 82K ohm, ¼W, 5%	01121	5-10823
R29	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R30	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R31	RC07GF823J	CC, 82K ohm, ¼W, 5%	01121	5-10823
R32	RC07GF103J	CC, 10K ohm, ¼W, 5%	01121	5-10103
R33	RC07GF472J	CC, 4.7K ohm, ¼W, 5%	01121	5-10472
R34	360T103B	Var, Cer, 10K ohm	71450	5-73103
R35	RC07GF681J	CC, 680 ohm, ¼W, 5%	01121	5-10681
R36	RC07GF222J	CC, 2.2K ohm, ¼W, 5%	01121	5-10222
R37	RC07GF123J	CC, 12K ohm, ¼W, 5%	01121	5-10123
		TERMINAL		
	2000C	Bifurcated	Useco	
	2000C	Bifurcated	Useco	
		TRANSFORMER		
T1	9402000	DC to DC Converter	34160	7-61009
		TRANSISTORS		
Q1	D44H2	NPN, Power	GE	3-24442
Q2	2N3694	NPN, Signal	07263	3-23694
Q3	D44H2	NPN, Power	GE	3-24442
Q4	D44H2	NPN, Power	GE	3-24442
Q5	D44H2	NPN, Power	GE	3-24442
Q6	2N5401	PNP, Signal	04713	3-25401
Q7	2N4275	NPN, Signal	07263	3-24275
Q8	2N4275	NPN, Signal	07263	3-24275
Q9	2N4275	NPN, Signal	07263	3-24275
Q10	2N3694	NPN, Signal	07263	3-23694
Q11	2N3694	NPN, Signal	07263	3-23694

Table 6-10. Parts List (Power Supply Sub-Assembly 9405028) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
Qty.		MISCELLANEOUS		
3		Eyelet		
1	2342	Spacer, ½" L	83330	
1	MS51957-19	Screw, PanHead, 4-40 x ¾"		
3	MS35333-70	Washer, 4-40 Int. Lk		
1	9402044	Heat Sink Plate	34160	1-10633
2	MS24693-4	Screw, 100° Flat,4-40 x 3/8		
2	NAS671C4	Nut, 4-40 Plain Hex		
2	DF-103C	Mica Insulator	86684	
2	DF-137A	Washer - Insulating	86684	

Table 6-11. Parts List (Display Assembly 9405029)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9405030	Master Bd. Sub-Assy.	34160	
	9405031	Vert. Output Sub-Assy.	34160	
	9402030	Front Panel - Display Sect.	34160	1-10619
V301	D10-240GH	Cathode Ray Tube	Brimar	3-40003
	9402026	CRT Shield	34160	1-10617
	9402020	CRT Filter	34160	4-20130
	9403010	Graticule	34160	4-20131
	9402035-1	Front CRT Support - Top	34160	1-10625
	9402035-2	Front CRT Support, Bott.	34160	1-10625
	9402036	Rear CRT Support	34160	1-10626
	9402040	CRT-Master Bd. Bracket	34160	1-10630
	9402052	Vert. Output Bd. Bkt.	34160	1-10635
L201	9402027	Trace Angle Coil	34160	5-90004
	9402054	Delay Cable	34160	2-70009
	9402047	Anode Insulator	34160	
	9402034	Center Shield	34160	1-10624
	9402037	Channel Brace	34160	1-10627
2 Req.	RN55D2001F	Res, MF, 2K ohm, 1/8W,1%	91637	5-51222
	651	Anode Clip	83330	4-20141
	8787	Spacer, 4-40 x 15/16"	83330	
	2374	Spacer, 4-40 x 1"	83330	
8 Req.	MS24693-3	Screw, 100°Flat,4-40 x 5/16"		
5 Req.	MS51957-13	Screw, PanHead, 4-40 x ¼"		
4 Req.	MS51957-14	Screw, PanHead, 4-40 x 5/16"		
4 Req.	MS51957-15	Screw, PanHead, 4-40 x 3/8"		
13 Req.	MS35333-70	Washer,4-40 Internal Lk		
9 Req.	NAS671C4	Nut, 4-40 Plain Nex		

Table 6-12. Parts List (Master Board Sub-Assembly 9405030)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO
	9403030	Etched Circuit Bd.	34160	1-20069
		CAPACITORS		
C301	5GA-S10	CD, .01 uf ±20%, 1KV	56289	6-29053
C302	5HKS-S10	CD, .01 uf ±20%, 500V	56289	6-28103
C303	DDM-503	CD, .05 uf ±20%, 100V	71590	6-29050
C304	DDM-503	CD, .05 uf ±20%, 100V	71590	6-29050
	02-011-113-3-200	Elco Pin Strip	Elco	
	02-024-113-3-200	Elco Pin Strip	Elco	
	02-015-013-5-200	Elco Pin Strip	Elco	
		RESISTORS		
R301	RCR20G825JS	CC, 8.2M ohm, ½W, 5%	01121	5-20825
R302	RCR20G515JS	CC, 5.1M ohm, ½W, 5%	01121	5-20515
R303	RCR20G395JS	CC, 3.9M ohm, ½W, 5%	01121	5-20395
R304		TBD		
R305	360T104B	Var, Cer, 100K ohm	71450	5-73104
XV301		Socket, CRT	Inter-Technical Group, Inc.	2-60006
		MISCELLANEOUS		
Qty.				
2	9402041	Master Bd. Bracket	34160	1-10632
2	MS51957-13	Screw,PanHead 4-40 x ¼		
2	MS35333-70	Washer No. 4 Int. Lk		
2	NAS671C4	Nut, 4-40 Plain Hex		

Table 6-13. Parts List (Vertical Output Sub-Assembly 9405031)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9403031	Etched Circuit Bd.	34160	1-20070
		CAPACITORS		
C1	T362C476M020AS	Tant, 47 uf ±20%, 20V	05397	6-74476
C2	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C3	T362C476M020AS	Tant. 47 uf ±20%, 20V	05397	6-74476
C4	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C5	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C6	T362C476M020AS	Tant, 47 uf ±20%, 20V	05397	6-74476
C7	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C8	UK20-104	CD, .1 uf +80 -20%, 20V	71590	6-24104
C9-N	DM15ED300J03	DM, 30 pf ±5%, 500V	04062	6-19300
C10	DDM-503	CD, .05 uf ±20%, 100V	71590	6-27503
		CHOKES		
L1	.115 x .125	Ferrite Bead	Amidon	5-90001
L2	.115 x .125	Ferrite Bead	Amidon	5-90001
		DIODES		
CR1	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR2	5082-2800	Schottky, 5082-2800	Hewlett Packard	3-12800
CR3	1N914	GP, 1N914	07263	3-10914
CR4	1N914	GP, 1N914	07263	3-10914
CR5	1N914	GP, 1N914	07263	3-10914
CR6	1N914	GP, 1N914	07263	3-10914
		INTEGRATED CIRCUITS		
U1	U5F7733393	Amp, 733	07263	3-30733
		RESISTORS		
R1	RC07GF332J	CC, 3.3K ohm, ¼W, 5%	01121	5-10332
R2	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R3	360T501B	Var, Cer, 500 ohm	71450	5-73501
R4	RC07GF102J	CC, 1K ohm, ¼W, 5%	01121	5-10102

Table 6-13. Parts List (Vertical Output Sub-Assembly 9405031) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R5	RN55D1001F	MF, 1.00K ohm,1/8W, 1%	91637	5-51193
R6	RC07GF100J	CC, 10 ohm, ¼W, 5%	01121	5-10100
R7	360T101B	Var, Cer, 100 ohm	71450	5-73101
R8	RC07GF680J	CC, 68 ohm, ¼W, 5%	01121	5-10680
R9	RC07GF680J	CC, 68 ohm, ¼W, 5%	01121	5-10680
R10-N	RC07GF101J	CC, 100 ohm, ¼W, 5%	01121	5-10101
R11	RC07GF151J	CC, 150 ohm, ¼W, 5%	01121	5-10151
R12	RC07GF151J	CC, 150 ohm, ¼W, 5%	01121	5-10151
R13	RC07GF152J	CC, 1.5K ohm, ¼W, 5%	01121	5-10151
R14	RC07GF152J	CC, 1.5K ohm, ¼W, 5%	01121	5-10151
		TRANSISTORS		
Q1	MPSH34	NPN, Signal	04713	3-20034
Q2	MPSH34	NPN, Signal	04713	3-20034
Q3	MPSH34	NPN, Signal	04713	3-20034
Q4	MPSH34	NPN, Signal	04713	3-20034

Table 6-14. Parts List (PS940 Final Assembly 9405033)

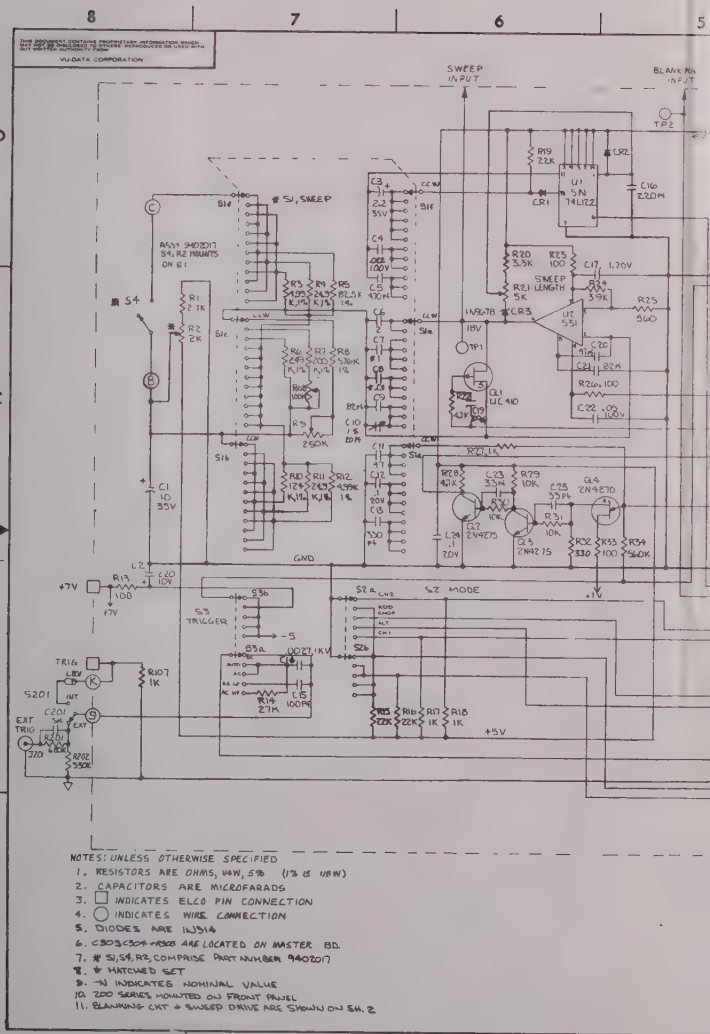
REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9405020	Vertical Module Assy.	34160	
	9405026	Horz. Module Assy.	34160	
	9405027	Power Supply Assy.	34160	
	9405029	Display Assy.	34160	
	9402005	Handle	34160	1-10614
2 Req	9402006	Handle Support	34160	1-10615
	9402009	Panel Spacer	34160	1-10602
	9402014	Top Cover	34160	1-10611
	9402015	Bottom Cover	34160	1-10612
	9402019	Bezel	34160	1-10609
	9402024	Protective Hood	34160	1-10616
	9402025	Trim Strip	34160	1-10618
2 Req	9402043	Handle Cover	34160	1-10637
	9402048	Side Panel - Right	34160	1-10638
	9402049	Side Panel - Left	34160	1-10639
4 Req.	F4B	Cabinet Feet	Budwig	4-20037
	SPH-386	Power Cord	Belden	2-70005
	9005016	Input Cable Assy	34160	
	MS24693-24	Screw, 100° Flat, 6-32 x ¼		
4 Req		Screw, 82° Oval Cross Recess 6-32 x 3/8		
2 Req	MS24693-25	Screw, 100° Flat 6-32 x 5/16		
11 Req	MS24693-2	Screw, 100° Flat 4-40 x ¼		
4 Req	NAS671C4	Nut, 4-40 Plain Hex		
8 Req	MS35333-70	Washer, No. 4 Internal Lk		
14 Req	MS51957-13	Screw, Panhead, 4-40 x ¼		

SECTION VII

DRAWINGS

List of Drawings:

Figure 7-1. Horizontal Assembly Schematic 9401023
Horizontal Assembly Schematic 9401023 (Continued)
Figure 7-2. Vertical Assembly Schematic 9401024
Figure 7-3. Power Supply Assembly Schematic 9401028
Figure 7-4. Vertical Output Schematic 9401031
Figure 7-5. Wiring Diagram Display Section 9401029


SWEEP INPUT
BLANKING INPUT
TP2
S1, SWEEP
AS SY 940207 S1, R2 MOUNTS ON S1
S1
S4
R1 2.7K
R2 2K
R3 R4 R5 24.3K 24.3K 81.5K
R6 R7 R8 200 200 536K
R9 100K
R10 260K
R11 R12 4.99K 24.3K
C1 10 35V
C2 .22 35V
C3 2.2 35V
C4 .022 100V
C5 470M
C6 .022
C7 #1
C8 #1
C9 .82M
C10 1 & 10M
C11 #1
C12 #1
C13 #1
C14 #1
C15 100PF
C16 220M
C17 1.20V
C18 .82M
C19 .82M
C20 10V
C21 .82M
C22 .02 100V
C23 33M
C24 .82M
C25 33PF
C26 .01
R19 22K
R20 3.3K
R21 SWEEP LENGTH 5K
R22 3.9K
R23 100
R24 3.9K
R25 560
R26 100
R27 1K
R28 42K
R29 10K
R30 10K
R31 10K
R32 330
R33 100
R34 560K
CR1
CR2
CR3
U1 SN 74L122
U2 551
1N967B 18V
TP1
Q1 UC410
Q2 2N4275
Q3 2N4275
Q4 2N4870
GND
+7V
+1V
-5
+5V
S2 MODE
S2a
S2b
S3 TRIGGER
S3a
S3b
S5
S6
R13 100
R14 100
R15 22K
R16 22K
R17 1K
R18 1K
R107 1K
R19 27K
C201
S201
TRIG
EXT TRIG
R201 330
R202 330K
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE OHMS, 1/4W, 5% (1/2 IS 1/8W)
2. CAPACITORS ARE MICROFARADS
3. □ INDICATES ELCO PIN CONNECTION
4. ○ INDICATES WIRE CONNECTION
5. DIODES ARE 1N914
6. C303 C304 R305 ARE LOCATED ON MASTER BD.
7. # S1, S4, R2, COMPRISE PART NUMBER 940207
8. $ MATCHED SET
9. -N INDICATES NOMINAL VALUE
10. 200 SERIES MOUNTED ON FRONT PANEL
11. BLANKING CKT & SWEEP DRIVE ARE SHOWN ON SH. 2

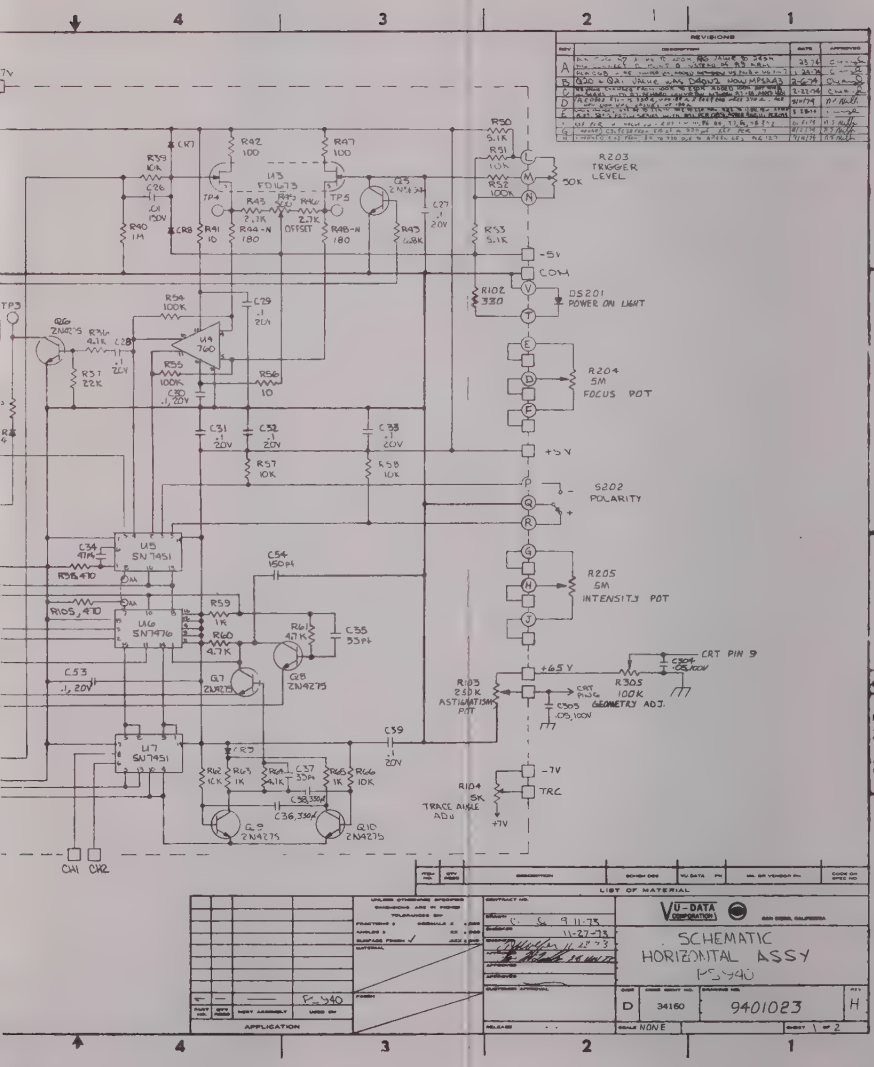
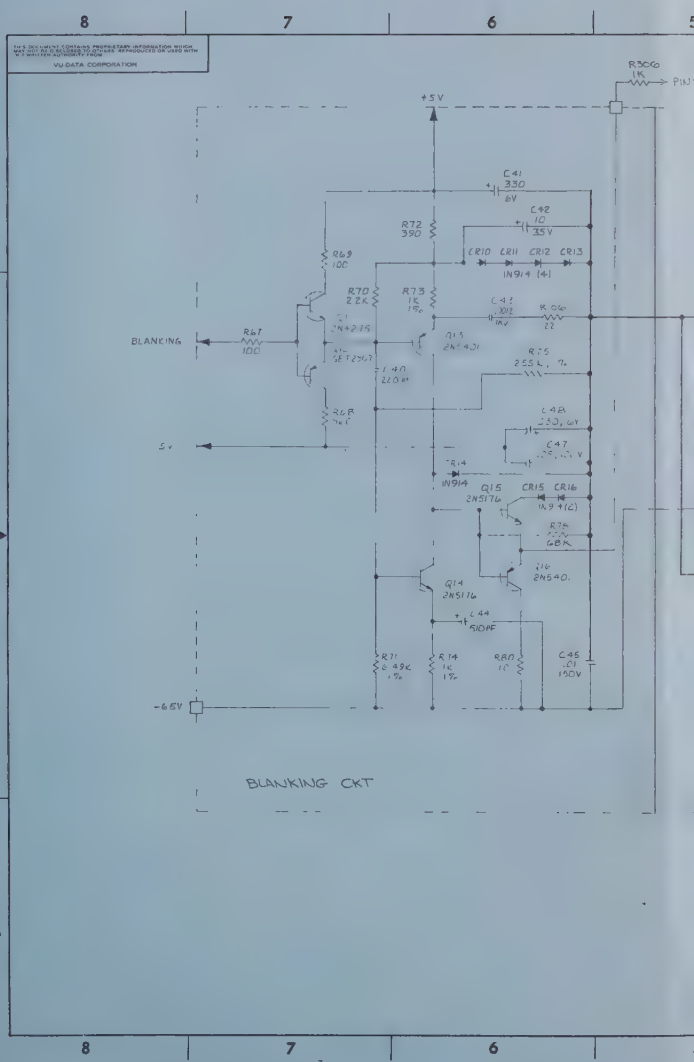


Figure 7-1. Horizontal Assembly Schematic 9401023


8
7
6
D
C
B
A
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VU DATA CORPORATION
R3GG
1K
PIN
+5V
C41
330
6V
C42
10
35V
R72
390
R69
100
CR10 CR11 CR12 CR13
IN914 (4)
R70
22K
R73
15
1%
C43
.001
1KV
R66
22
BLANKING
R67
100
Q13
2N4431
R75
2.55 L, 1%
1.40
220 Ω
R68
7K
C48
.22, 6V
5V
C47
.05, 10V
CR14
IN914
Q15
2N5176
CR15 CR16
IN 914 (2)
R76
68K
Q16
2N5401
Q14
2N5176
C44
.01MF
R71
6.49K
1%
R74
1K
1%
R80
10
C45
.01
150V
-65V
BLANKING CKT

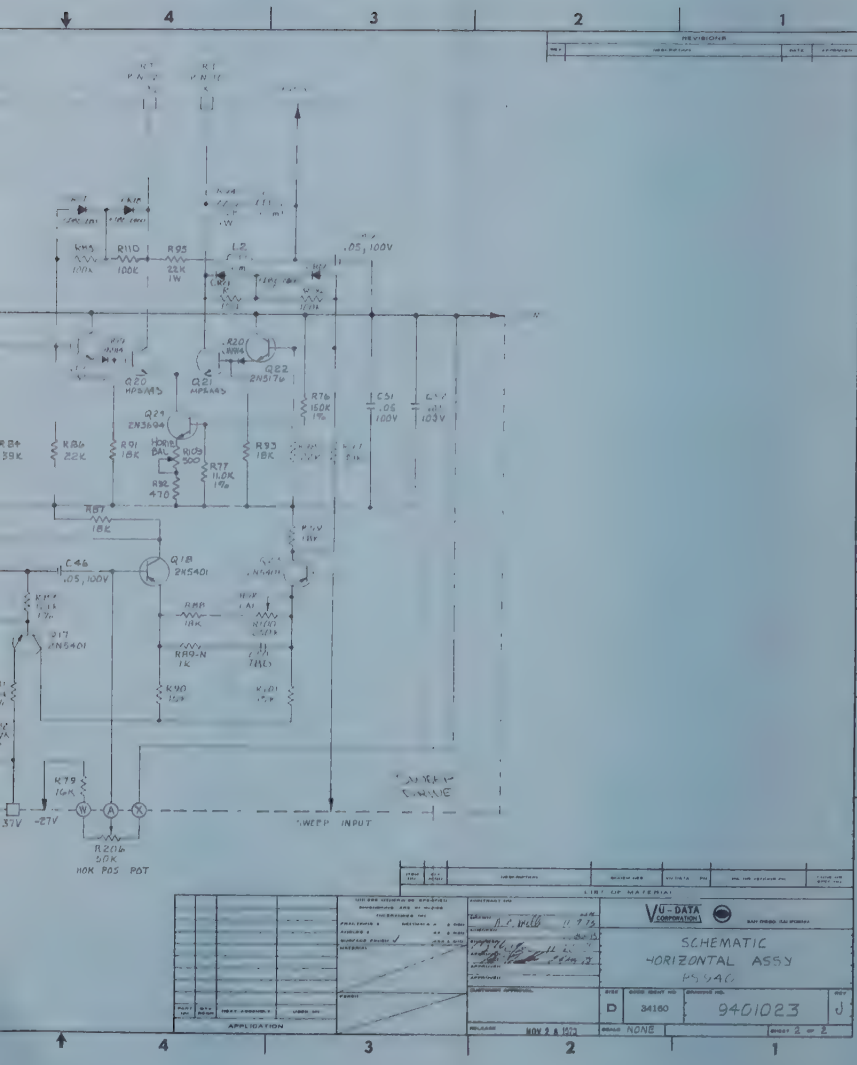
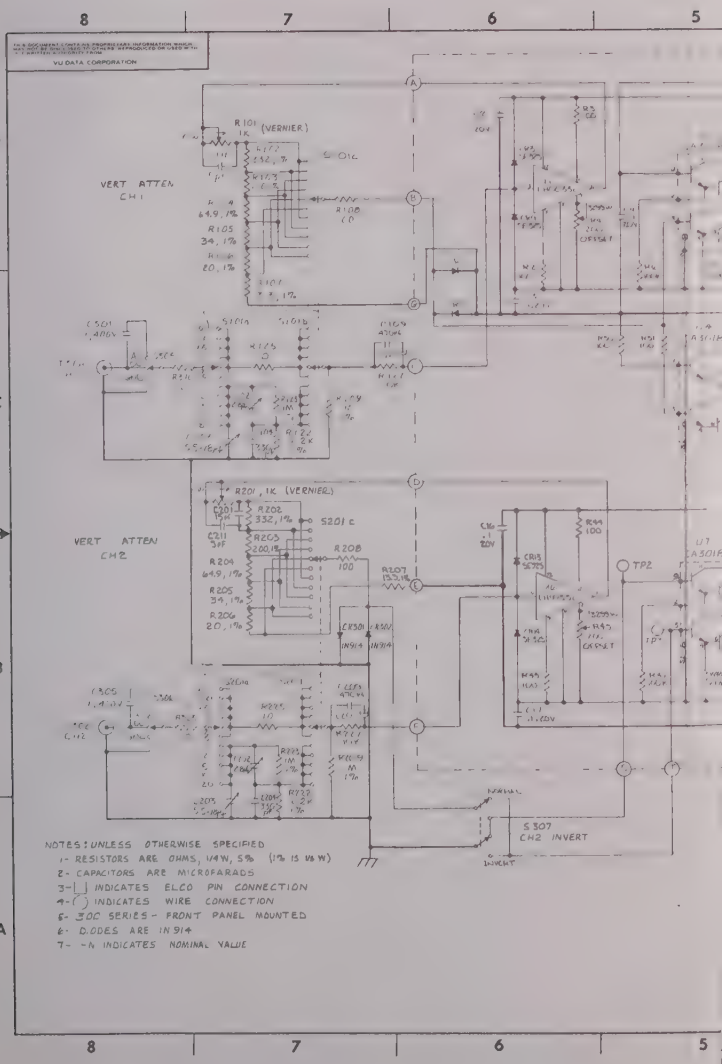


Figure 7-1. Horizontal Assembly Schematic 9401023 (Continued)


VU DATA CORPORATION
R101 1K (VERNIER)
VERT ATTEN CH1
R105 34.1%
R106 20.1%
R108 10
S201 C
R201 1K (VERNIER)
VERT ATTEN CH2
R204 649.1%
R205 34.1%
R206 20.1%
R208 100
R207 133.1%
CR301 1N914
CR302 1N914
TP2
S307 CH2 INVERT
NORMAL
INVERT
NOTES: UNLESS OTHERWISE SPECIFIED
1- RESISTORS ARE OHMS, 1/4W, 5% (1% IS 1/8 W)
2- CAPACITORS ARE MICROFARADS
3- INDICATES ELCO PIN CONNECTION
4- ( ) INDICATES WIRE CONNECTION
5- 300 SERIES - FRONT PANEL MOUNTED
6- DIODES ARE 1N914
7- -N INDICATES NOMINAL VALUE

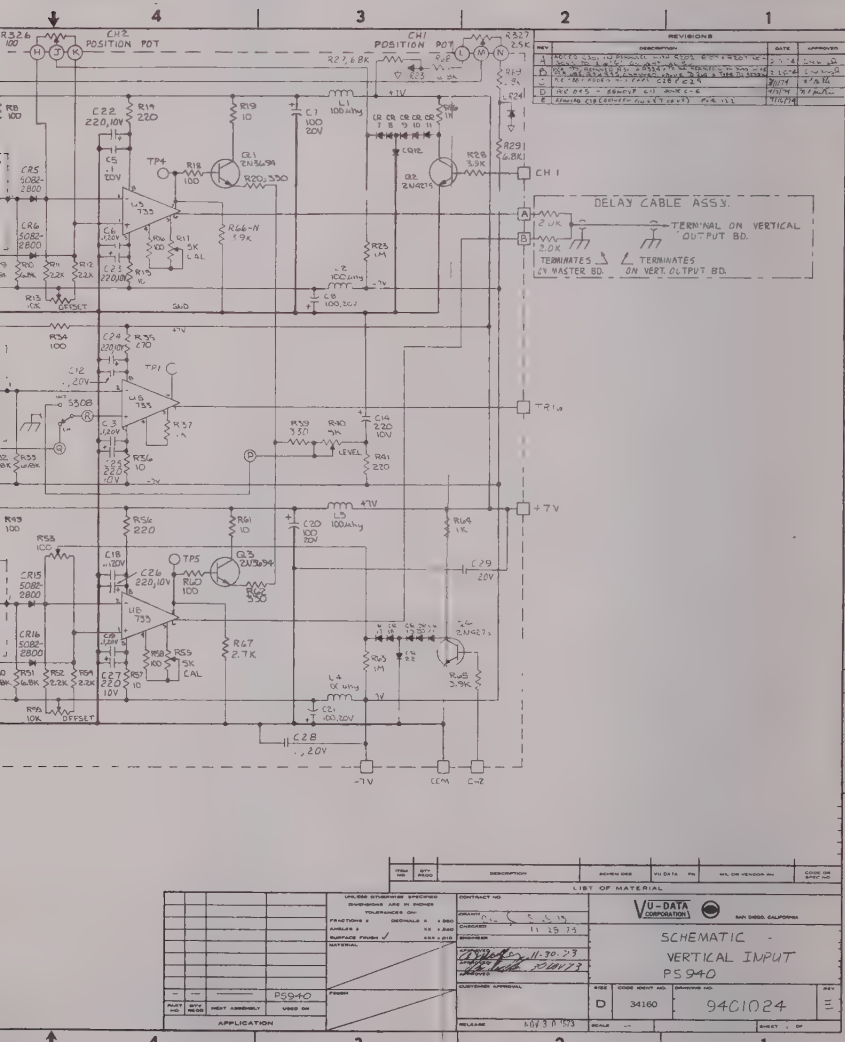


Figure 7-2. Vertical Assembly Schematic 9401024

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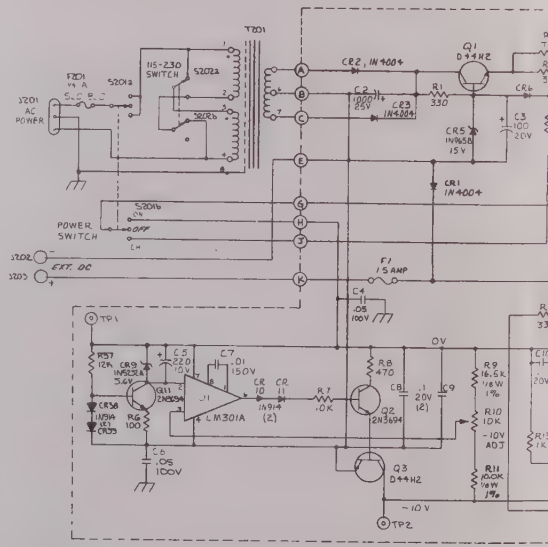
VU DATA CORPORATION



NOTES: UNLESS OTHERWISE SPECIFIED

1- ALL RESISTORS ARE OHMS, 1/4W, 5%
2- ALL CAPACITORS ARE MICROFARADS
3- 300 SERIES COMPONENTS ARE LOCATED ON MASTER P.C. SUB-ASSY
4- □ INDICATES P.C. PIN CONNECTION
5- ○ INDICATES WIRE CONNECTION
6. 200 SERIES COMPONENTS ARE LOCATED ON REAR PANEL SUB ASSY

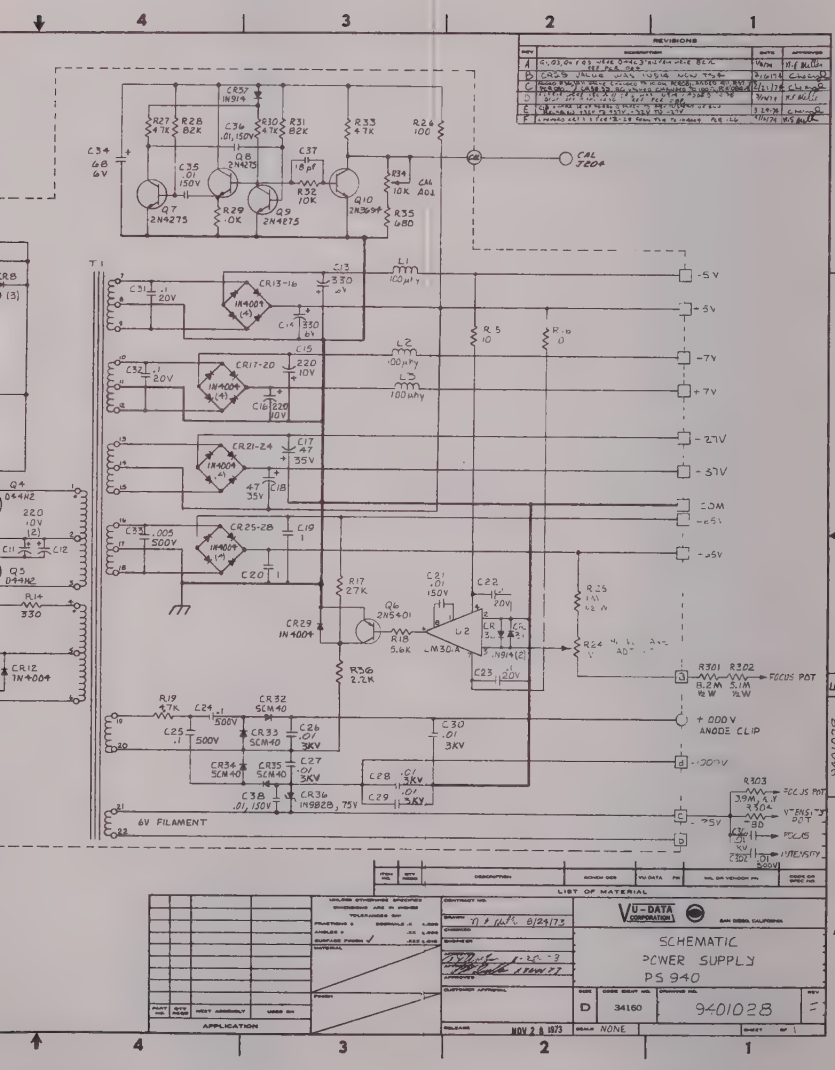


Figure 7-3. Power Supply Assembly Schematic 9401028

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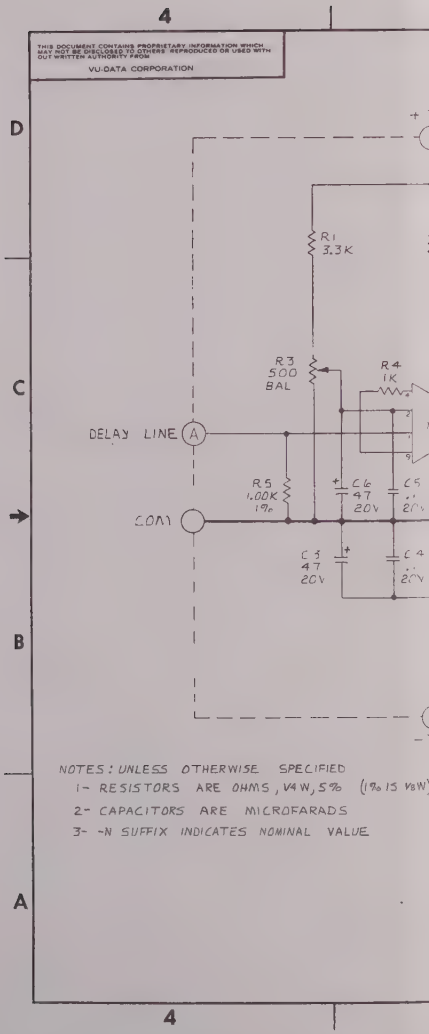


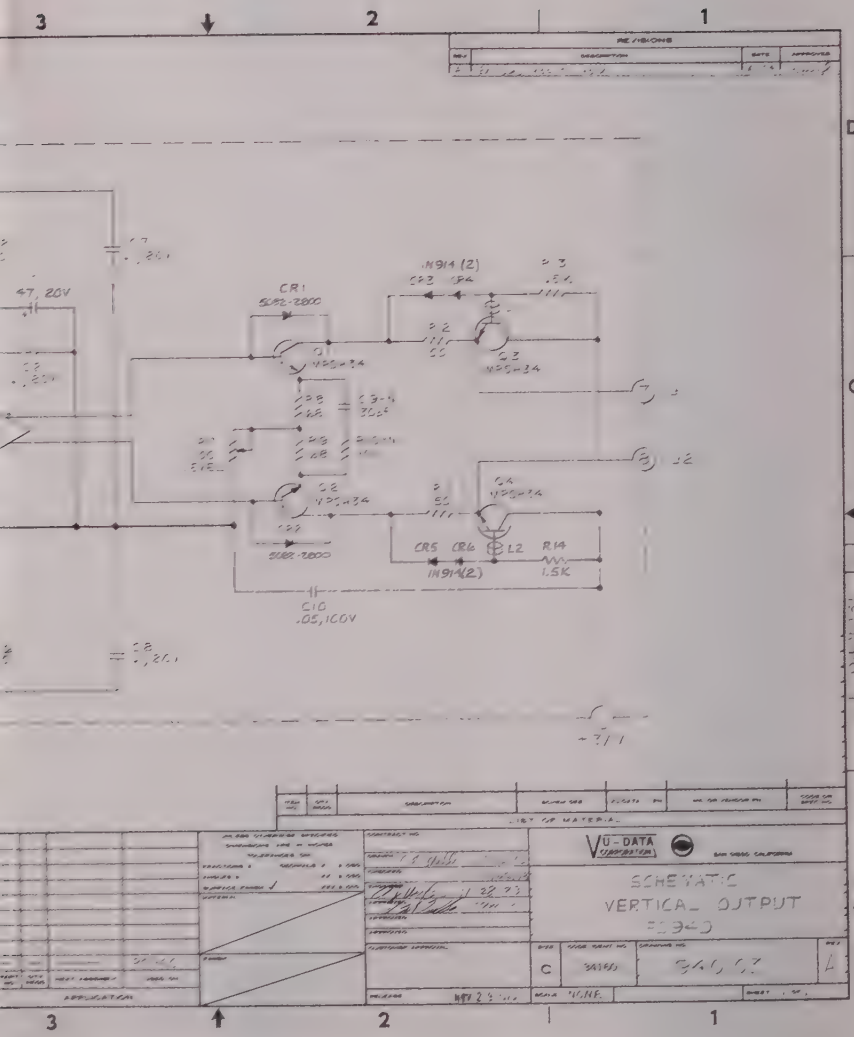
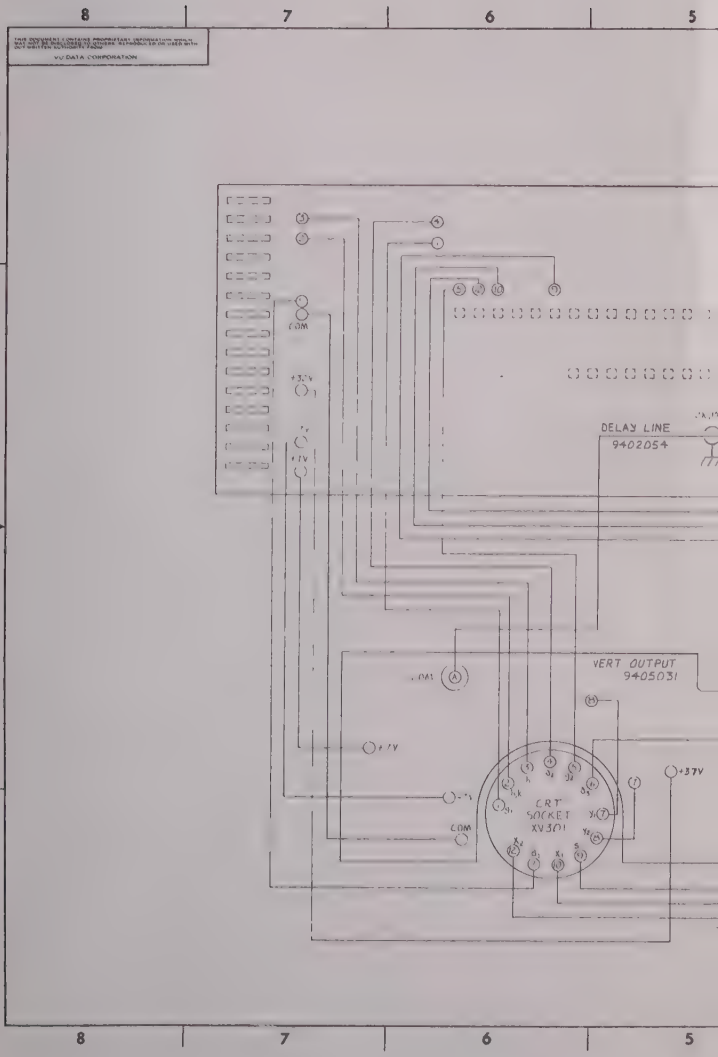


Figure 7-4. Vertical Output Schematic 9401031


8
7
6
5
D
C
B
A
VV DATA CORPORATION
COM
+37V
+17V
DELAY LINE
9402054
VERT OUTPUT
9405031
CRT
SOCKET
XV301
+37V
COM

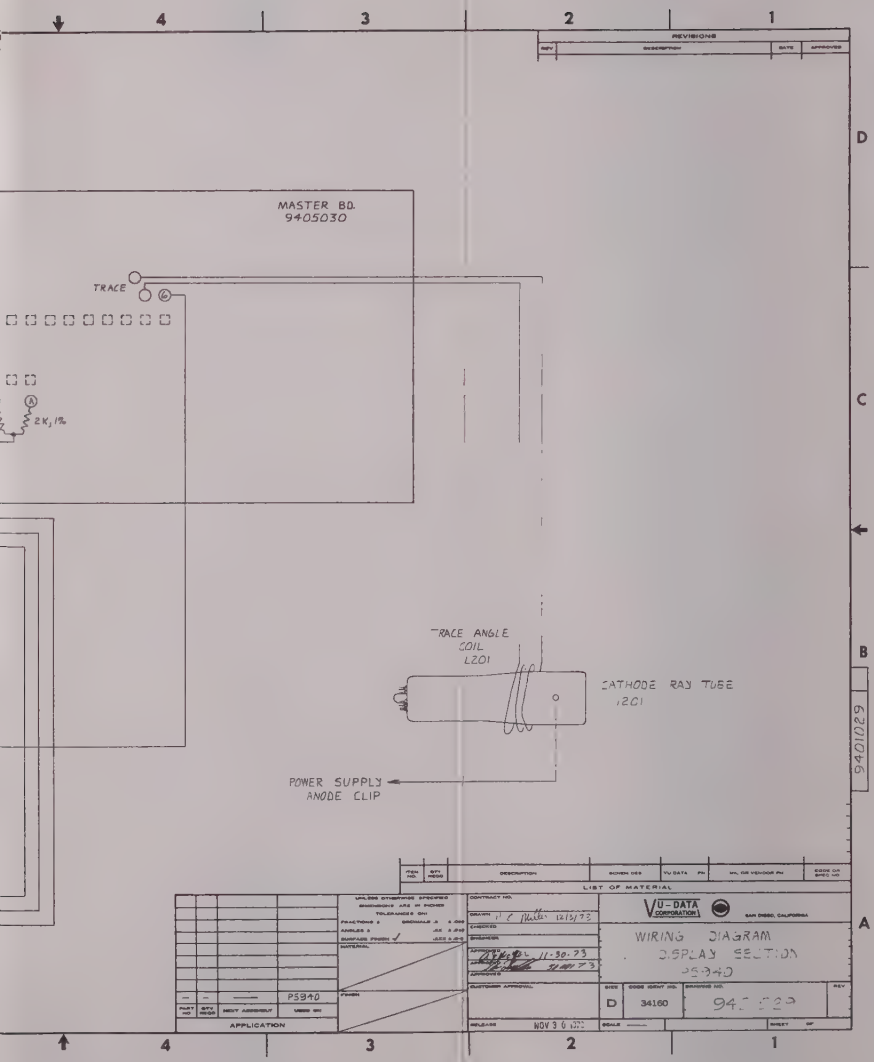


Figure 7-5. Wiring Diagram Display Section 9401029

SECTION VIII

RECOMMENDED SPARES

following is a list of recommended spare parts required to maintain a specific number of instruments satisfactory level of performance of one year in an isolated area.

ASSEMBLY OR PART NAME		PART NUMBER	QUANTITY OF PARTS		
			1 Inst.	5 Inst.	10 Inst.
t. Module Assy.	9405020		1	1	1
riz. Sub-Assy.	9405026		1	1	1
wer Supply Assy.	9405027		1	1	1
T Assy.	9405029		1	1	1
rt. Output Sub-Assy.	9405031		1	1	1
nsistor NPN Signal	MPSH34	3-25H34	2	5	10
nsistor NPN Power	D44H2	3-24442	2	2	6
nsistor NPN Signal	2N4275	3-24275	4	10	20
nsistor NPN Signal	2N3694	3-23694	4	10	20
. Amp	LH0033C	3-33033C	1	2	5
. Amp	CA3018	3-33018	1	2	5
. Amp	733	3-30733	1	3	5
pacitor, Tant	T362D107M 020AS	6-74107	1	5	10
pacitor, Tant	T362D227M 010AS	6-76227	1	5	10
pacitor, Tant		6-74476	1	5	10
ode	1N4004	3-14004	1	2	5
ode	SCM40	3-10350	1	2	5
ode	5082-2800	3-12800	2	5	10
ansformer					
DC-to-DC Converter	9402000	7-61009	1	1	2
ansformer, Power	9402001	7-61010	0	0	1
wer Cord	SPH-386	2-70005	1	1	2
se, 1.5 Amp FB	3AG15APT	2-40013	1	2	5
se, ¼A Slo Blo	3AG.25ASB	2-40004	1	2	5

MODEL NUMBER_____ SERIAL NUMBER_____

WARRANTY

VU-DATA CORPORATION hereby warrants to each original purchaser of all instruments of Vu-data Corporation manufacture as follows:

I. At the time of delivery of all instruments to the original purchaser thereof, Vu-data Corporation UNCONDITIONALLY WARRANTS that all of such instruments shall be free from defects in parts, materials, and workmanship; and

II. Commencing with the date of delivery of all instruments to the original purchaser thereof, which delivery date for purposes of this warranty shall be deemed to be Vu-data Corporation's original shipment date, AND FOR A PERIOD EXPIRING ONE (1) YEAR FROM SAID DATE, Vu-data Corporation UNCONDITIONALLY WARRANTS that all such instruments shall remain free from defects in parts, materials, and workmanship.

In the event any instrument shall fail to meet the terms of this warranty, Vu-data Corporation agrees that if the original purchaser of any such instrument shall:

(1) Give to Vu-data Corporation's customer service department prompt notice in writing of the nature of any suspected defect; and

(2) Upon receipt of written authorization and shipping instructions from Vu-data Corporation, return the instrument with suspected defects, transportation charges prepaid, to Vu-data Corporation's main plant located in San Diego, California; then Vu-data Corporation shall replace any and all defective parts/materials and shall repair any and all defective workmanship and shall return the instrument, TRANSPORTATION CHARGES COLLECT, in good working order and state of repair to the original purchaser thereof, or in the alternative, Vu-data Corporation shall have the option to replace any such defective instrument by substituting a new instrument of the same type therefor, ALL WITHOUT ANY CHARGE WHATSOEVER:

The warranties herein contained shall not obligate Vu-data Corporation in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection of the instrument by Vu-data Corporation are not to Vu-data Corporation's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship.

Vu-data Corporation reserves the right to modify or change the design or appearance of any of its instruments as it deems desirable. Nothing herein contained shall preclude such right or create any obligation to effect such changes on units previously purchased.

The remedies herein specified in the event of a breach of any of the warranties herein contained shall be the sole and exlusive remedies for such breach.

The warranties herein contained are intended to be and shall be construed as being in addition to and cumulative to all implied warranties contained in the Uniform Commercial Code, provided, however, that in the event of any breach by Vu-data Corporation of any of the implied warranties contained in the Uniform Commercial Code neither the purchaser of any Vu-data Corporation product, nor any other person, shall be entitled to recover by reason of such breach any incidental damages or consequential damages as those terms are defined in subsection 2–715 of the Uniform Commercial Code.

All warranties herein contained shall run only in favor of the original purchaser of Vu-data Corporation's instruments and all such warranties shall immediately terminate and become null and void and of no further force or effect whatsoever upon the sale or other transfer of any such instrument by the original purchaser. The warranties herein contained constitute the sole and exclusive warranties made by Vu-data Corporation of its instruments and no other express warranties not herein contained are given and no affirmation of fact, promise or representation made by any agent, employee or representative of Vu-data Corporation shall constitute a warranty. No agent, employee or representative of Vu-data Corporation has any authority to bind Vu-data Corporation in any affirmation of fact, promise, representation or warranty not herein expressly contained.

The above statements and warranty constitutes a part of Vu-data Corporation's standard Terms and Conditions of Sale as published in our Order Acknowledgement which together is Vu-data Corporation's warranty in its entirety.